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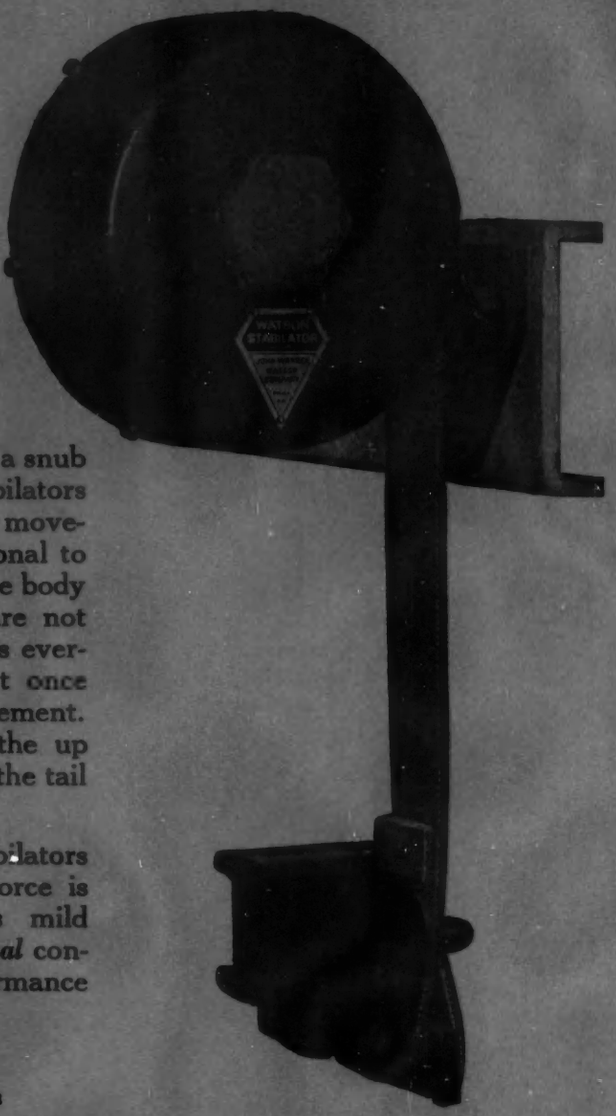
NOVEMBER 1924

PRODUCTION MEETING NUMBER

SOCIETY OF AUTOMOTIVE ENGINEERS INC.
29 WEST 39TH STREET NEW YORK

The Basic Difference between STABILATORS and all other Devices—



INSTEAD of stopping spring rebound with a snub or jerk at the tail end of the upthrow, Stabilators get on the job at the very beginning of the up movement with a drag which is always proportional to the rebound force. They thus firmly ease the body back to its normal position. Passengers are not catapulted from the seats. By means of this ever-present, proportional control, Stabilators at once put an end to any violent throwing movement. Starting the drag from the beginning of the up movement there is no violence of motion at the tail end of the movement.

And Stabilators don't bind you down. Stabilators hold powerfully only when the rebound force is powerful. When the rebound force is mild Stabilators hold but mildly. This *proportional* control is the whole secret of Stabilator performance and success.

President

John Warren Watson Company
Twenty-fourth and Locust Streets
Philadelphia

(*Detroit Branch:* 51-53 Canfield Avenue, East)

WATSON STABILATORS

They Work

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

Vol. XV November, 1924 No. 5

Chronicle and Comment

Research Manager of the Society

JOHN A. C. WARNER, who has been Assistant Manager of the Research Department since June 1, 1923, was appointed manager of that department at the last meeting of the Council. For some few months past he has had full charge of the activities of the Research Department.

Handbook Too Large for One Binder

THE number of data sheets in the S. A. E. HANDBOOK of Standards has increased to a point where it is no longer convenient to keep all of the sheets in one binder. Because of a recent reduction in the price, the Society can now furnish extra binders to members at $2.50 each. It is suggested that Sections A, B and C be kept in one binder and Sections D to M inclusive be transferred to another binder.

Highway Work by Research Council

SINCE Charles M. Upham, state highway engineer of North Carolina, has become director of the Advisory Board on Highway Research of the National Research Council, the work that was initiated and carried on by Dr. W. K. Hatt has been extended where practicable.

In response to the proposal that more practical application of highway research be put into effect, 40 State Highway Commissioners have named representatives on this Advisory Board.

American Museum of Safety

THE American Museum of Safety, 120 East 28th Street, New York City, is run in cooperation with the Department of Labor of the State of New York. In the machine room, electric drive with individual motors, except for a lineshaft shown to teach certain things, is used. The elevator shows many kinds of door and interlock.

The members have been cordially invited to visit the museum, and criticisms of the exhibits from them will be welcomed.

Position of Speedometers

A CAR-OWNER resident in California writes: Speedometers are supposed to be mounted in a position where they can be read conveniently by drivers. But, as in many cases they are placed on the right side of the instrument-board, it would seem that they are supposed to be more for the edification of passengers. This is not as it should be.

A driver wishes to know constantly what the car speed is, especially when traveling fast. Any movement of the head or eyes other than perpendicularly causes the driver to lose his line of vision, to regain which is more or less confusing and may cause accident.

A speedometer should always be placed as nearly as possibly directly in front of the driver. It is surprising that leading manufacturers have not realized this.

Joint Collection of Society and Sections Dues

THE effect of the joint collection, through the Society office, of Society and Sections annual dues is naturally being watched with interest. This plan was inaugurated this fiscal year that began Oct. 1 last.

Of those members who had paid Society dues for this year by Oct. 18 over 62 per cent paid Sections dues as well. Nearly 44 per cent of those who at the time stated had paid Sections dues for this year did not pay Sections dues for the last fiscal year. Accordingly, there is good evidence up to this date that the joint method of billing will result in an increased number of Society members joining the local Sections.

Standardization of Colors for Traffic Signals

THE Executive Committee of the Sectional Committee on Standardization of Colors for Traffic Signals has completed a preliminary draft of the code covering the use of luminous and non-luminous signs and signals in connection with highway traffic, including moving and flashing signals; and the use of lights, semaphores and other signaling devices on vehicles. The colors used in the code are defined qualitatively. The general significance of colors used as signals is established in the following terms:

(1) Red shall be used as an indication to stop and for other purposes where required by law
(2) Yellow shall be used as an indication to exercise caution
(3) Green shall be used as an indication to proceed

The significance of form of signal used either alone or in combination of colors is then specified, including semaphore indications. General principles are laid down for the design of cautionary and traffic-control signs, and

a distinction is made between signs for notice of pedestrians and of operators of vehicles. The speed of operation of flashing signals, the brightness and spread of illumination, the color of head-lamps, tail-lamps, warning lights and marker lights are covered. While the code is not yet complete or any part thereof finally adopted, satisfactory progress has been attained, and further steps toward finishing this important work will be taken in due course.

Motorcoach Standardization

AT the joint meeting of the American Electric Railway Association Subcommittee on Motorcoaches and of the Motorcoach Committee of the Society, held at Atlantic City last month, reference was made to the effective manner in which the proposed New Jersey specifications had been circularized by the Society among motorcoach manufacturers and to the cooperation of the latter in drafting satisfactory requirements. Another joint meeting of the committees will be held early this month to review the proposed New Jersey specifications.

The committees are also making a study of the matter of differences in actual outside-diameters of tires of different makes, of the same nominal diameters, as reported by the Motor Transit Co. of Los Angeles. An effort will be made to remedy the situation in this respect.

Carbon Monoxide

WHEN carbon monoxide is breathed it combines with the blood. The more carbon monoxide there is in the blood, the less oxygen the blood will hold. It is stated by the American Gas Association that as low as 0.1 per cent of carbon monoxide, or even less in the air, will kill a man in time; and that 1 per cent will kill in a few minutes.

In fresh air, carbon monoxide leaves the blood in a few hours. There are various kinds of apparatus for treating gas poisoning by the inhalation of oxygen and carbon dioxide. It has been proposed by some that inhalation be given regularly to every mechanic who has been working on a car with the engine running, so as to eliminate carbon monoxide from his blood before he leaves his work for the day.

Head-Lamp Illumination and Glare

IN a memorandum on the headlight question prepared by President Crane recently, it is stated the first head-lamps of any real power on motor cars were of the acetylene type. When first used they were criticized severely as producing glare. This was due to the fact that most other vehicles had either no lights at all or only very ineffective oil-lamps. When the electric head-lamp was introduced as a part of automobile equipment, the number of motor cars on the road was increasing rapidly; the combination created a very unsatisfactory condition. This was due partly to the early design of the electric head-lamp, in which the most piercing beam possible was produced by the aid of a high-power bulb in connection with a parabolic reflector. Conditions rapidly became intolerable with the large number of electrically lighted cars in use, and various methods of regulation were undertaken.

In the early regulations, the question of glare was treated as of paramount importance, and practically nothing was done to assure that a safe driving-light would be attained. Consequently, the Society and the Illuminating Engineering Society took up the whole subject in a very thorough manner, with the result that a certain form of light distribution was worked out as being the best compromise between the absence of glare and the presence of sufficient light for safe driving.

This driving light is obtained by the use of either special mirrors or lenses, or both, in connection with the very definite adjustment of the head-lamps themselves. The requirements have been put into force in a considerable number of States during the last few years, by legislation or regulation. Only one or two States have, however, made serious effort to enforce the regulations.

It becomes more and more apparent, as time goes on, that we have not yet reached an ideal solution of the problem. In the first place, the recommended light-distribution is planned on the basis of two vehicles approaching each other on a level road and without any considerable amount of spring action. This is due to the necessity of keeping the piercing part of the light-beam as high as possible without actually shining in the eyes of the drivers of approaching vehicles. The desired condition is badly upset on roads of a rough contour or even on roads of a rough variety which cause a vehicle to pitch on its springs.

Furthermore, the accurate embodiment of the desired light-distribution requires rather expensive lamp equipment, as well as a certain amount of attention and care on the part of car-owners. At this writing the lamp equipment of the lowest-priced cars cannot be expected permanently to fulfil the requirements of this type of regulation.

It is desirable that complete enforcement be had of the regulations as they now exist in the various States, to the end that public education may be advanced and a demand created for more efficient lighting equipment. Furthermore, further consideration of the whole subject should be undertaken with the purpose of obtaining regulation that will permit of a more desirable form of lighting equipment than is now required. The equipment should be simple and after being installed should continue to give good service, even in the hands of the most careless driver. It is thought that possibly some form of diffused light would meet the requirements of vehicles of moderate speed, such as trucks or the lower-priced passenger-cars.

Cooperation

IN a stirring address presented at the Production Meeting of the Society last month, C. A. Lippincott, chief of the cooperating department of the Studebaker Corporation of America, made some very telling remarks regarding industrial cooperation. It is axiomatic, he said, that cooperation is essential to success. The fundamental problem in all organized effort is the problem of human relations. This problem must be solved before industry can have a high degree of efficiency.

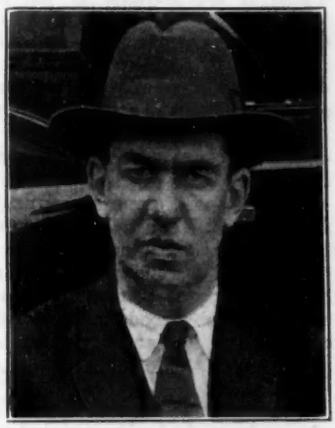
Mr. Lippincott is convinced that paternalistic welfare systems are unsound ethically and economically. They bestow something for nothing. The man who accepts gratuities pays too great a price for them. They destroy moral fiber, which is the essence of character.

One of the ringing sentences with which Mr. Lippincott concluded his address was: The doing of simple justice is the fundamental prerequisite of cooperation.

MEETINGS OF THE SOCIETY

ARMY TRUCK ENGINEERING PROGRESSES

Motor Transport Chief Engineer Describes Design, Testing and Repair Activities



A. W. S. HERRINGTON

If the United States ever has the great misfortune to participate in another war, the Army's motor-transportation system will be found ready for duty. The confusion of 1917 and 1918 will not be repeated. There will not be 103 distinct makes of 3-ton trucks facing the repair shop mechanics, for the Army has profited by the lessons learned in France. Motor vehicles have been studied, designed and tested until a limited number of types has been chosen to fulfill all requirements. The engineering work incident to this standardization and development has been carried on by the Engineering and Design Section of the Quartermasters Corps at its headquarters in Baltimore. Arthur W. S. Herrington, chief engineer of the Section, outlined the work of his department, described some of its original designs of four-wheel-drive and six-wheel trucks and discussed many interesting details of motor-truck design before the Indiana Section of the Society on Oct. 2. An abstract of his remarks follows.

Mr. Herrington said that his department is charged with the responsibility of handling all engineering problems pertaining to all vehicles of the Army that run on wheels. This includes even the old escort-wagons carried down from Civil War days and it is of interest to know that these are being fitted with roller bearings in all wheel hubs so that they may be towed by motor vehicles in an emergency. At present the automotive equipment includes the following types: 1½, 3, 5 and 7-ton capacity rear-wheel-drive trucks; 500 to 1000-lb. capacity light delivery trucks; four-wheel-drive and six-wheel trucks of recent design; five and seven-passenger cars; motorcycle with side-car and a solo motorcycle.

ARMY POLICY FAVORS COMMERCIAL DESIGNS WHERE PRACTICAL

It is not the policy of the Quartermaster Corps to make specialized Army designs of all these units. Some vehicles must be specialized and the design of these must be undertaken by force of circumstance. The four-wheel-drive truck is an example of this class. It is a military necessity, yet its development by commercial organizations has practically ceased because of the vast expansion of good roads. Where reliable and suitable vehicles can be selected from commercial production, the Army prefers these since they can be obtained in large quantities with minimum delay should a war emergency arise. Mr. Herrington estimated that it would take the entire output of three commercial-vehicle factories to supply trucks in sufficient quantity at such a time.

In addition to its design and development duties, the Engineering Section must test and write specifications for all material, parts and supplies used in the motor-transportation service of the Army. This includes gasoline, oil, tires, spark-plugs, accessories, spare parts, brake-lining and the like. Items that are not covered fully by specification must be tested by the Engineering Section and put on an "approved list" before they can be purchased. In some instances these tests develop into valuable engineering investigations. For example, the brake-lining research at the Bureau of Standards was conducted at the request of the Motor Transportation Engineering Section. The valuable results of this investigation were made available to the industry through papers read before the Society and published in THE JOURNAL.[1] Problems that require scientific research work for their solution are assigned to the Bureau of Standards in this way. Mr. Herrington cited comprehensive valve-tests made by the Engineering Section to select suitable valves for Class B trucks from a mass of samples that ranged in price from 90 cents to $3.50 each. A valve was selected finally which gave six times better service than the most expensive sample and two times better life than the cheapest, yet cost only $1.10.

Sometimes it is necessary for the Engineering Section to develop special vehicles for a particular service in another division of the Army. For example, a four-wheel-drive truck was recently converted into a bomb-handling unit to be used at aviation fields for loading bombing airplanes. In another case the same standard unit was adapted to portable searchlight work. Equipped with a dump body, the same chassis was fitted for the road-building work of the Corps of Engineers. In each instance these units are basicly standard, hence would be available in quantities in war time.

BEARING REPLACEMENT-COST CUT 90 PER CENT

Another Engineering Section activity is the maintenance and the rebuilding of the Army's motor vehicles. Since many of these are of 1917 vintage and must be kept in service for a few more years, this branch of the work is no small task. New methods and tools for servicing motor equipment are receiving constant study. A standardized tool for boring crankshaft bearings has recently been adopted by the Army and this effects a reduction of 90 per cent in the cost of installing new bearings in an engine. Mr. Herrington said that the resulting job was better than could be obtained by hand-scraping and he predicted that the hand-fitting method will soon be extinct. This one boring tool can be adjusted to bore the bearings in every size and type of engine in the Army's motor-transport service.

The four-wheel-drive truck designed by the Engineering Section was shown at the 1924 Summer Meeting and has

[1] See THE JOURNAL, March, 1922, p. 153.

The full story of the Production Meeting begins on p. 376

been described fully in the trade press. It is driven by a four-cylinder engine of standard design manufactured by any one of several engine builders. Engine, radiator, transmission, clutch and carbureter are all standard production units. Only the axles and a special reduction-gear unit mounted behind the transmission are not commercial designs. The special reduction-gear provides eight forward and two reverse speeds when used with the conventional four-speed transmission.

The track-laying tractor has its limitations in motor-transport service, said Mr. Herrington. Its great trouble lies in the short life of the track. For the same reason, little success has been had with trucks designed to use portable tracks. Also, these tracks weigh as much as half the pay load and are an encumbrance that must be carried when the truck is running on conventional wheel equipment.

Commenting on maintenance, Mr. Herrington said that designers must give more thought to accessibility for repairs and adjustments. Labor is the most expensive item in repair costs and the man-hours needed to get at inaccessible parts must be reduced. Mr. Herrington expressed the opinion in the discussion that six-wheel trucks would not find much use below the 3-ton size. In the case of buses where riding-quality is a factor, six wheels may be used in the lighter vehicles.

BALLOON-TIRE PROBLEMS DISCUSSED

Shimmy, Punctures and Absence of Standards Enliven Milwaukee Section Meeting

Scheduled as a Riding-Quality meeting, the session of the Milwaukee Section in Racine, Wis., Oct. 8 developed into a most interesting discussion of tire manufacture, tire merchandising practice, wheel shimmy, spring periodicity, the deplorable lack of balloon-tire standards and many other matters related to the corpulent offspring of the tire industry. Most of the balloon-tire problems of the hour were dissected, but the cure for shimmy, susceptibility to punctures and hard steering was not forthcoming. The meeting was an all-day affair which opened in the morning with visits to the plants of the Ajax Rubber Co. and the Harvey Spring & Forging Co. Luncheon was served at noon by the local gas company. Whether this had any significance has not been recorded in the reports of the meeting. In the afternoon there was a golf tournament, this divertissement apparently having become an essential feature of engineering meetings of this day and age. All events were very well attended, several Chicago Section representatives coming up to enjoy the attractive program.

Claims Made for Balloon Tires

L. J. D. Healy, technical supervisor of the Fisk Rubber Co., gave the members a most instructive exposition of the steps taken and materials used in the manufacture of automobile tires and touched briefly on the development of the modern balloon cord tire from the pioneer work of John Dunlop in 1888. Mr. Healy said that the balloon tire has effected a great improvement in riding comfort. Greater safety has been provided by its increased traction. The balloon tire has proved very nearly as reliable as the high-pressure tire. The Fisk fleet of test cars using balloon tires has demonstrated that there is practically no greater puncture, cut, or blow-out hazard than with high-pressure tires. As to durability, the balloon tire compares favorably with the high-pressure tire. There is slightly greater tread wear, but Mr. Healy felt confident that this will be overcome by proper design and distribution of the tread stock. The efficiency of the balloon tire is about the same as that of the high-pressure variety as used ordinarily with reduced air pressure, a practice that is almost universal on passenger cars driven by their owners. The rolling-resistance of the balloon tire is slightly greater than that of a high-pressure tire inflated to the correct pressure. So far as ease of replacement is concerned, there is no difference between the two types of tire.

Two outstanding disadvantages of the balloon tire were cited by Mr. Healy; these are, hard steering and wheel shimmy. He contends that hard steering can be overcome by suitable changes in the design of the steering mechanism and the relation of the tire and wheel to the road. Wheel shimmy, on the other hand, seems to be a peculiar characteristic of some cars and is absent in others. Mr. Healy believes that this is due to peculiarities in the design of the car and is a problem for the car designer to solve.

Balloon Tires Tend to Wear Faster

Balloon tires have a tendency to wear faster on the tread than high-pressure tires due to the greater frictional movement encountered over road obstructions and the greater deflection of the tire. Front tires seem to wear greatest on the outside edge of the tread; rear tires wear greatest on the inside edge of the tread. The former condition is attributable to the increased pitch and toe-in of the wheels, while the latter is due to the crown in the road. Off-center wear is more pronounced on the front tires.

In Mr. Healy's opinion, the tire of the future will develop along the lines of the balloon tire. It will be a tire of great flexibility, generously proportioned and as light as practicable. It will be suited to light-weight rims because of the general tendency to reduce unsprung weight to the minimum.

Louis Monk, general manager of the Harvey Spring & Forging Co., read a brief paper describing a form of spring that has a great many thin center leaves with a heavy master and a rebound leaf. Spring action is so distributed by the shape of this spring that all small bumps and vibrations are absorbed in its ends. Interleaf friction is increased by the large number of thin leaves.

Low-Priced Tires Do Not Pay

Mr. Healy said that there is little difference in the quality of single and double-cured tires; in fact, he favored the former construction. In his opinion all tires made by the more responsible companies have about the same wearing qualities; they contain practically the same quantity of rubber and cotton. Referring to the practice of making two grades of tire, Mr. Healy said that he did not favor it. There is no economy in buying the cheaper grades, but they are in demand for used cars. In general, the public wants the best quality of tire that can be bought. Cheaper grades or fewer plies of cotton are used to reduce the manufacturing cost of low-priced tires. The rubber itself is so low in cost that it does not pay to adulterate it or use reclaimed rubber. Cord fabric now costs about 60 cents per lb.; rubber can be bought for 30 cents per lb. Although there is more rubber than fabric in a tire, the fabric represents nearly half the material cost.

D. M. Averill of the Ajax Motors Corporation called attention to the need for standardization of balloon-tire sizes, Mr. Healy replying that the tire manufacturer would like nothing better than a reduction of sizes since he could build first-quality tires for less money. Mr. Averill said "the work of the Society is of the greatest importance to the automotive industry. The biggest task before it today is standardization. There is no other way to effect standardization of tires than by concerted action on the part of the engineers. The effect of the Society's conclusions on the industry as a whole is far-reaching."

Caster Action Accentuates Shimmy

Cars whose front wheels are positioned to utilize caster action are more likely to have pronounced shimmy trouble than the others, said Mr. Healy. In some cases he has reduced the tendency to shimmy by increasing the toe-in of the front wheels. The angle of the steering-knuckle axis is another influential factor. If a car tends to shimmy with high-pressure tires, this tendency will be increased when balloon tires are fitted.

There was a very lively discussion of spring characteristics. Mr. Monk said that the analysis of the steel in a spring bears no relation to its riding quality. Very good springs can be made of carbon-steel if properly designed.

Alloy-steels merely increase the life of a spring. To produce the same riding quality result, the same weight of either alloy or carbon steel will be needed. E. G. Gunn said that the number of oscillations of a spring is affected by interleaf friction but the time of the oscillations is not. F. C. Mock contradicted this since tests he has made of badly-rusted springs showed their period to be slower than that of a new spring. He also remarked that the bad pitching action of some cars is largely due to faulty weight-distribution. When the weight is distributed so that the deflections of the front and rear sprngs for a given bump are somewhere near being equal, pitching is minimized. A car having the weight concentrated midway between the front and rear wheels, such as a coupe or roadster, usually pitches badly.

WHEN IS A PIRATE PART?

Replacement-Parts Makers Lead Animated Discussion at Metropolitan Section

Is any replacement part not made by the original maker of the car a pirate part? Many car manufacturers buy the parts from outside firms. If the makers of these parts also sell the parts to garages or to owners direct, do these parts *ipso facto* become pirate parts? Does the fact that a part passes through the plant of the car maker or through his service-station relieve it of the stigma of being a pirate part and change it from a pirate to a puritan? These and other similar questions enlivened the regular monthly meeting of the Metropolitan Section held at the Hotel Cumberland, New York City, on Thursday, Oct. 16. At the next meeting of the Section the manufacturers will have their innings and will be given an opportunity to state their side of the question.

The Parts Manufacturers Viewpoint

Mr. Durnin of the Houpert Machine Co., expressed the sentiments of the parts makers concisely when he said:

> Considerable stress has been put on genuine parts by car manufacturers and it is possible that the car manufacturers may have overstepped themselves a little in this respect. A number of manufacturers of replacement parts have made an investigation and find that approximately 35 per cent of the parts used in the various cars are made by the car manufacturers themselves and the rest are made outside the factory. The parts manufacturer, in many cases, is supplying parts to a car manufacturer as well as to the replacement parts trade. Let us take the manufacturer of valves. He supplies valves, we will say, to a dozen car manufacturers and he also supplies valves of the same identical type to jobbers throughout the Country. The motor-car manufacturer, through his local service-station, impresses upon the car-owner the necessity for using none but genuine parts and brands anything but the genuine parts as pirate parts. It would seem then that the mere detail of that product's passing through the storeroom of the car manufacturer relieves it of the stigma of being a pirate part. Then, too, times occur when the local service-station cannot possibly secure from the factory the parts that it needs to service the cars in its territory and the service-station then buys its parts from a local jobber or the manufacturer. Is the car so equipped a pirate car, or has the fact that the local service-station bought these parts and installed them magically transferred them from pirates to puritans? Suppose it were possible to pass a law forbidding anyone other than the manufacturer of a car to manufacture a part for that car. In what condition would the automotive trade find itself? The competition of replacement-parts manufacturers has enabled the car-owner, the repairman and even the local service-station to render a service to customers that could not be rendered if they all were to depend upon the car manufacturer; and the replacement-parts manufacturer has made it possible for the owner of the car to make changes that the owner has deemed desirable and that could not have been made had he depended entirely upon the car manufacturer.

J. C. Gorey

J. P. Orteig

Replacement-parts manufacturers, he said, are divided into two classes: (*a*) those who take pride in their work and build it up to a quality, not down to a price, and (*b*) those whose aim is to grind out dollars through converting raw material into a commodity that resembles an automobile part, without regard to whether it will meet the requirements of the service for which it is intended, in other words, to build down to a price rather than up to a quality. One fills a legitimate demand, the other is a pirate. No business, he said, can exist unless it fills a legitimate place in the industry as a whole. If the replacement-parts manufacturer is prospering it is because he is supplying a product that meets a legitimate and reasonable demand. The reasons given by the car manufacturers for trying to prevent the use of parts other than their own, he said, are many, but the only real one is, that it is their will that it shall be done. The market for replacement parts is to be found not in the service-stations alone but in the general run of garages and repair shops and in the owners themselves.

Term "Pirate" Objectionable

J. P. Orteig objected to the term "pirate" or "bootleg" parts because of the inference that those who carry them in stock are lawbreakers. On the contrary, he said, these dealers are rendering a distinct service to the industry that will increase in importance. The business had been given a great impetus during the war, when the demands upon the car manufacturers for new equipment were so great that they were unable to furnish small quantities of parts not only for obsolete cars but even for the later models. But the parts had to be found and he had been obliged to install machinery, he said, to make the parts that he could not obtain otherwise. At that time the car makers were very glad to have the cars serviced by outside sources and in fact welcomed it. During the period of depression after the war, when the car manufacturers sought new business for their idle machinery, they suddenly woke up to the fact that the business that they had considered to be theirs exclusively had passed into other hands. The term "pirate" parts was therefore coined, as well as the more uptodate term "bootleg" parts.

How many car builders, said he, are making and stocking parts at the present time for cars that were made in 1915, 1916 and 1917? If the car maker has abandoned his interest in these cars where is the car-owner to go for the parts, for many of these cars are still in service? Who will take care of "orphan" cars? Although abuses have crept in, many instances have occurred in which the parts maker has rendered the car manufacturer a service by substituting an improved part for a faulty one. The suggestion was made that some provision should be made so that all parts supplied by outside makers should be stamped with the maker's name and the parts identified. Inasmuch as they obtain their raw

material from the same sources and have access to labor of equal skill, why should not the parts makers, he asked, be able to produce parts of just as good quality as the car manufacturers? The fact that the replacement-parts maker can usually undersell the car manufacturer is due to his smaller overhead expense.

J. C. Gorey stated that when he began stocking parts for cars in 1910, he found that five makes of cars were equipped with the same front and rear axles, two well-known makes contained the same units and three cars were using the same type of transmission. He said his stock at present contains several thousand parts of each unit. He hoped that clearing houses would soon be established in the large cities where standard parts of all cars could be obtained.

Cost of Replacement Parts

Figures submitted by A. R. Mogge, merchandising director of the Automotive Equipment Association, showed that in 1923 the public had spent $650,000,000 for replacement parts and $910,000,000 for labor; that 70,000 organizations, of which 31,500 are car-dealer service-stations and 37,500 are independent service-stations doing repair work are competing for maintenance; that of the 42,831 passenger-car dealers in business, 74 per cent operate service-stations and do repair work, 71 per cent sell tires and only 65 per cent have accessory and supply departments. Within the last 5 years the number of dealer shops has increased 20 per cent, while during the same period the number of independent shops has increased 110 per cent.

He emphasized the need of encouraging the use of dependable replacement parts and, with a view to merchandising these parts properly, he itemized the suggestions recommended in the program of the Association. These are:

(1) Greater standardization of the parts used, the elimination of odd sizes and the avoidance of changes with every new model
(2) Further recognition of recognized channels of distribution of dependable replacement-parts
(3) Provision for supplying sales and service organizations with more intelligent information regarding the stocking and selling of replacement-parts
(4) Better and more complete interchangeability lists
(5) An advertising program to reach the motoring public, calling attention to the importance of patronizing well-equipped shops supplying dependable replacement-parts

High Spots of the Discussion

In the discussion, M. C. Horine explained that the difference between the parts made by the manufacturer of the car and those made by a replacement-parts maker usually lay in the inspection, the car manufacturer, having the good will of the customer in mind, being far more particular.

B. W. Adler averred that his company maintained as accurate an inspection department as the car manufacturers and that the parts are serviced in the best manner possible. The thing to do, he said, was to give the customer every consideration and the best service obtainable.

Mr. Gorey elaborated on the service feature, saying that in each of the branches of his company an index was kept of the places at which persons can get genuine repair parts for their cars, and to these firms they were referred many times each day.

H. R. Cobleigh stressed the importance of cooperation, saying that the question had two sides: The car builder has the reputation of the car to maintain, while the parts maker strives to do the same for the part. Some car manufacturers resent the fact that dealers choose to specialize on parts that have the quickest turnover whereas the poor car manufacturer must stock all kinds. In a Pirate Parts Bulletin issued by the National Automobile Chamber of Commerce, pirate parts are defined as "those that either infringe a patent or are sold under misrepresentation as being something other than that which they really are." If a parts maker stamps the part with his own name and infringes no patent he is not making a pirate part. Success in any line, he said, lay in supplying something for which there is a public demand.

D. F. Kalish of the Spicer Mfg. Corporation asserted that the chief trouble lay in the fact that replacement-parts were not always sold for what they were supposed to be but in many instances were sold as genuine.

Replying to questions by Chairman Masury, Adolph Moses, and A. G. Scheller, J. C. Houpert of the Houpert Machine Co. explained in detail his method of making pistons, many of which are in use as standard equipment.

C. O. Bech laid particular stress on the importance of interchangeable parts and drew a picture of the ideal system in which all parts are made in accordance with S. A. E. Standards, by which any part can be replaced with another in a few minutes. He said he hoped to see the time when the same system could be extended to engines as well.

SOLVING THE TRAFFIC PROBLEM

System of 204-Ft. Super-Highways Contemplated in Detroit Plan

Photo by C. M. Hayes & Co., Detroit
SIDNEY D. WALDON

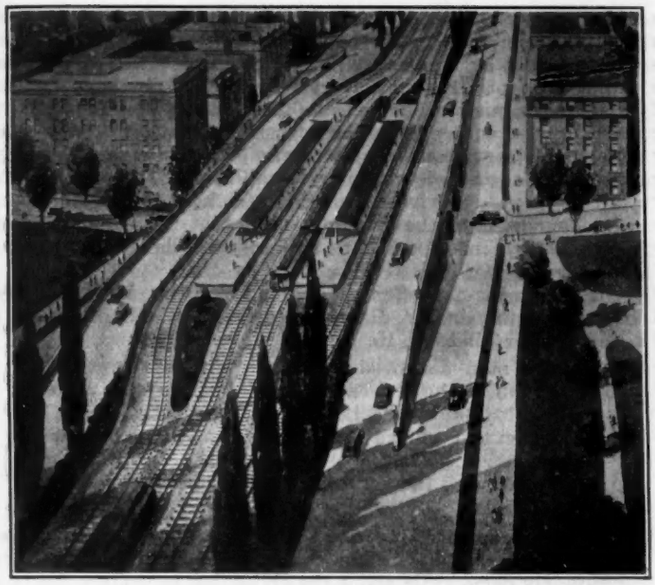
The city traffic tangle is the most serious problem confronting the motor-using public and the automotive industry today. This opinion, which was addressed by Sidney D. Waldon to the Detroit Section at its October meeting, is shared by every engineer possessed of good judgment. Mr. Waldon, who is chairman of the Rapid Transit Commission of Detroit, held the interest of his audience with descriptions of super-highways 204 ft. wide which will accommodate express and local automobile traffic as well as a four-track system of rail transportation. The keynote of his address was the necessity of laying ambitious highway plans at the present time so that future city development may be made to conform with such plans at the minimum of expense.

Some indication of the rapid development of the traffic problem in our larger American cities can be obtained from Mr. Waldon's statement that 53,000 new vehicles were registered in Wayne County, Mich., in 1 year. Fifty-three thousand automobiles, each occupying 26 ft. of road space would require a highway 265 miles long. Parked at the curb they would require a street 86 miles long. What is the use of talking about solving the traffic problem by shaving sidewalks for a few blocks when 1 year's increase of vehicles would utilize both sides of an 86-mile highway?

Every mile of automobiles can be translated into a certain potential purchasing power. If the radius of action of an owner's car is suddenly increased 10 or 20 times, then his purchasing power is made available over the greater area. The automobile makes land accessible, more useful and consequently more valuable. Wipe out the automobile and you restrict purchasing power and wipe out hundreds of millions of dollars worth of land value.

A Master Plan of Highways Essential

The solution of the traffic problem resolves itself into two distinct parts; what should be done in the county and State where land is relatively unimproved; and what should be done in the cities where expensive buildings make changes costly and extremely difficult. In the case of the State, the first essential is the creation of a master plan covering all the intercity routes of importance that belong in the trunk-line



THE 204 FT. SUPER-HIGHWAY

Four Lines of Rapid-Transit Tracks Are Shown in the Center, One Pair Being for Local and the Other for Express Traffic. This Space Is 84 Ft. Wide. On Either Side of the Central Rail-Area Are Twin Motor-Vehicle Roads. The Inner Roads Are for Express Motor-Transport and Are Carried over Cross Roads at Railroad Stations as Shown. The Outer Motor Roads Are for Local Traffic and Are Flanked by Sidewalks. The Motor Roads Are Each 20 Ft. Wide So That 80 Ft. of Roadway Is Provided for Motor-Vehicle Traffic

highway-system. These routes are the most important in the State. They may only represent 10 per cent of the total highway mileage, but authorities estimate that they carry 90 per cent of the total vehicular traffic. A master plan is of equal importance to every township, county, city or village. Only by the most careful study of existing and desired routes within the locality itself, and their relation to similar routes in adjoining areas, and particularly their relation to routes of state-wide importance, will it be possible to prepare a proper master plan. After preparing a master plan and having determined the standards of necessary road-width, the next step is to acquire the rights-of-way at the earliest practicable moment. These must be obtained while the land is relatively cheap and before improvements make condemnation expensive or impossible.

In the Detroit area, a system of super-highways has been laid out in conference with the authorities of all the adjacent counties. This system comprises 217 miles of 204-ft. right-of-way along routes that traverse, for the most part, what is now unimproved field and farm land. Steps are being taken to secure legislative action that will create a board empowered to acquire these rights-of-way, but not with the authority to improve them. The essential thing is to get the rights-of-way without further delay.

WHAT THE SUPER-HIGHWAY ACCOMPLISHES

The main objects of the 204-ft. roadway were summarized by Mr. Waldon as follows:

(1) To permit a variety of treatment in pavements, tree planting and the like, depending upon the requirements of the territory traversed

(2) To give increased capacity with increased safety and speed for motor-vehicle transportation

(3) By proper spacing of vehicle roadways, the center may be left free to provide for future train-operated rapid transit at a saving of almost one-half of the cost per mile of an underground system

(4) When surface rapid transit is provided with grade separations at the station points at half-mile intervals, the express motor-vehicle roadway can be carried above the same intersecting streets and provide a facility not now available to motorists anywhere

(5) The wide right-of-way will have capacity to handle the circulation and transportation of the occupants of the tallest structures. Being wide, the super-highway will not only attract these structures but will provide them with maximum light and air and a splendid setting

(6) Regardless of how the width of the super-highway may be utilized, it will permit the planting of trees and shrubbery in places along its route where they will not be disturbed by the successive steps in the evolution of its development.

BUILT-UP CITIES PRESENT MOST DIFFICULT PROBLEMS

What should be done in the older portions of cities is infinitely more serious and difficult of solution than the problem presented in the county and in the State. Again, in the case of the city, what is needed first is a master plan. This must be made up of a limited number of carefully selected streets, which, when linked together and properly opened and widened, will form a super-grid of highways to give equal service to all localities. Applications for the opening and widening of streets should not be approved unless they conform to the master plan. Actual widening of the routes in the plan itself can be accomplished in one of two ways. Where the route is of vital importance, and the improvement is essential at once, it should be accomplished by the usual condemnation proceeding. Wherever the improvement is not urgently needed, it may be accomplished through the adoption of set-back lines, and an agreement reached between the city and the property owners as to when the widening will be made effective.

The minimum width of concrete road being built in Wayne County today is 20 ft., but present plans are being made to increase this minimum to 40 ft. This latter figure represents the width needed for four lanes of travel. The average thickness of the latest Wayne County concrete roads is 9 in. The extension of Woodward Avenue leading out of Detroit is being widened to 200 ft. This will be the first super-highway in America. It will accommodate rail transportation in the center, have two 40-ft. vehicle roadways on either side and provide ample additional space for sidewalks, trees and shrubbery.

MAKING HIGHWAYS SAFE FOR DEMOCRACY

The Agencies and Methods Used for Attaining and Maintaining Safety

What has been done, is being done and will be done to make motor-vehicle traffic safe was ably presented by George M. Graham, chairman of the Traffic Planning and Safety Committee of the National Automobile Chamber of Commerce, who addressed the members and guests of the Pennsylvania Section, on the subject Creating Millions of Safe Drivers, at the meeting held on Oct. 14. Seventy were present at the dinner and, when the meeting began, 120 had assembled.

GEORGE M. GRAHAM

Sketching the amazing way in which the motor vehicle is changing our national economic and social life, and remarking that, previous to 120 years ago, development of the means of transportation had progressed but little since the beginning of the Christian

Era, Mr. Graham mentioned the transportation problem as having begun to exhibit its astonishing dimensions within the past 10 years, and outlined the scope and methods of the agencies now functioning in concentrated effort to cope with it. He stated the great problem to be the making of the automobile a public benefaction, in place of allowing it to be a menace, through the attainment of safe vehicular traffic on the streets and highways, and quoted the appalling statistics of fatalities charged against motor vehicles, whether deservedly or not, to emphasize the necessity for accomplishing a much greater assurance of safety to the public than now exists.

Means to this end have been, and are being, developed and promulgated by many powerful and nationally distributed agencies, such as the highways and utilities commissions and police departments; the builders of steam, electric and automotive vehicles; the users, as represented by the American Automobile Association and by the automobile clubs; the National Safety Council; labor organizations; the insurance interests and others. Their effort is being coordinated by the National Safety Conference.

Collection of adequate statistics and their analysis are prime necessities. Education in safety methods, regulation of traffic and punishment for offenses against safety depend upon them. Only eight States keep adequate records, and by "adequate" is meant the inclusion of all details of an accident that have a bearing on the determination of blame and the method of correction or degree of punishment. The National Automobile Chamber of Commerce has induced 286 newspapers of the Country to check-up and report upon each automobile accident of which an account is printed, and its committee broadcasts these reports in printed form, together with such recommendations as seem advisable in view of the respective causes of these disasters.

Corrective Measures

Education, divided into the creation of a proper public sentiment and the type that is represented by more or less coordinated civic action, inclusive of publicity of all sorts and specific instruction directed at the groups most concerned, is essential. A most important feature is the transmission to children of ideals of safety, a campaign that is being waged diligently.

Mr. Graham believes that most of the driving of motor vehicles is done conscientiously but that drivers should be instructed and cautioned incessantly and that all, as drivers, should set a good example of safe driving. Regarding standardized systems of motor-vehicle signals and regulations, he said that a nation-wide effort is being made by the Association of State Highway Officials, under the supervision of the Chief of the Bureau of Public Roads, to standardize them. In regard to semaphores and lights, he thinks it should be recognized that red means danger, to slow-up or stop, and that green means safety, or go-ahead. This is railroad practice and even children understand these meanings.

Grade Crossings

Quoting statistics for the last year, Mr. Graham deplored the fact that 1741 persons were killed in grade-crossing accidents. He said that 80 per cent of these people were riding in automobiles when the accident occurred and that he thinks almost full responsibility for such fatalities is attributable to the motorist, since he is on the railroad's right-of-way after danger has been indicated by its signs and signals. He is inclined to advocate a law that would compel a motor-vehicle driver to slow down to 10 m.p.h. when 300 ft. distant from a grade crossing and believes this would almost eliminate grade-crossing accidents.

Recommendations and Comment

Much discussion of the subject of having some system of licensing drivers only after they have passed a suitable examination has developed. Mr. Graham believes the fundamental principle sound, as the public has a right to know whether a person is physically and mentally competent to manipulate a motor vehicle but doubts the feasibility of its application, one reason being the millions of examinations that would be necessary. He directed attention to the fact that it is possible, in correcting manifest abuses, to go too far, make mistakes and create other evils. This is a liability not only in such matters as licensing but also in others such as compulsory insurance; for example, such a law would increase the cost of motoring to millions of people who are already "safe" drivers, and Mr. Graham, while admitting the soundness of the principle, feels that the point at which compulsory insurance can be accepted has not yet been reached.

Punishment for offenses against highway safety reaches its maximum, in Mr. Graham's opinion, when the driver is deprived of his car. He said:

> If a man cannot drive a car without jeopardizing the public, take the car away from him and regulate the period for which he must do without it according to the extent of the damage he caused by having an accident. . . . Such procedure should follow court hearings, with the accused person properly represented by counsel.

All the populace, big and little, rich and poor, must use the highways. Mr. Graham contends that there is something peculiarly democratic about the obligation to protect the public highways, and that no finer fulfilment of one of the duties of citizenship exists than to contribute adequately toward making those highways safe.

Observations Concerning Regulation

Interesting actual instances of motor-vehicle-traffic regulation were cited and helpful suggestions for controlling such traffic were made by Magistrate Yerkes, of Upper Darby, near Philadelphia, through which town approximately 50,000 motor vehicles pass each week, in the address he made following that of Mr. Graham. Among these statements was one of his agreement that punishment by depriving a driver of the use of his car would prove efficacious, and another of his belief that compulsory insurance is desirable. In this locality, 75 per cent of the traffic-law violators are of an ignorant or undesirable class, many of whom can neither read nor write. His reports for the last quarter show that, for each 15 speed-violators, 10 were drivers of motor trucks who allow their vehicles to coast down hill. Instances of the overloading of trucks were given and the good results that followed high fines imposed, as high as $200, were stated. He believes it necessary to create a fear of the law and that fear is the great deterrent. But he also emphasized the fact that law-enforcement officials are good friends of all who use the highways, not only as correctors of highway abuses but as protectors and as instructors of individual users of motor vehicles in practices that assure safety.

Informative Discussion

In reply to a query, Mr. Graham said that publications of rules governing interstate touring would be distributed after uniform rules are completed. The only nation-wide action of his organization at present is that of newspaper publicity regarding accidents. The methods of numerous safety organizations were commented upon by representatives present, inclusive of the Philadelphia Safety Council and the Keystone Motor Club. Comparisons were made and conflicts cited regarding motor-vehicle laws of States that adjoin, to show the need for uniformity. The new Pennsylvania law regarding motor-vehicle head-lamps and their proper focusing was mentioned, its desirability explained and the process of focusing the head-lamps on vehicles in actual operation was described. Due to eye reaction, the sight of drivers approaching each other at night is made unreliable for say 1.2 sec. when the intensity of light from oncoming head-lamps is reduced, as when the lamps are dimmed. It was ascertained that the greatest number of accidents occurred during that interval; some 3000 cars ran off the road.

Approximately 3500 signs were placed at dangerous intersections last year by the Keystone Club, which also had a traffic patrol of 11 men who worked each Saturday and

Sunday at dangerous crossroads in localities in which no funds were available to employ traffic policemen. The need for a properly organized specially designated traffic court in large cities like Philadelphia was stated.

Instances of reckless disregard for safety were given by E. S. Chapin of the Pennsylvania Railroad, who said that a check-up of accidents at railroad crossings showed that 3 per cent of the motor-vehicle drivers would race with trains for the crossing and smash through crossing gates; 384 gates were smashed in 3 months on the Pennsylvania lines. Some such drivers will turn a car around while on the crossing, or pass a car that has stopped for the crossing. In one instance a driver collided with the rear of a standing car and catapulted it onto the railroad tracks; in another, a motor-vehicle crashed through the crossing gates and derailed a train. He favors a law such as advocated by Mr. Graham; that is, to require a motor vehicle to slow down to 10 m. p. h. when 300 ft. distant from a railroad grade-crossing.

EUROPEAN AUTOMOTIVE PRACTICES

Can Europeans Best Americans in Far-Reaching Automotive Development?

Recent European automotive design was illustrated by lantern slides and instructively discussed by Prof. C. A. Norman, of Ohio State University, at the meeting of the Cleveland Section held Oct. 20. He was at great pains to select designs that actually have been tried-out in practice, in most instances for rather extended periods, and excluded designs that might well be classified as freakish, for any reason. He believes American engineers are alive to the possibilities of improvement in design along the lines indicated by the more than 40 views he exhibited; and he feels that if the automotive engineering talent in this Country were concentrated upon some of the more far-reaching lines of development now in progress in Europe, instead of being spent in some instances at least upon small routine-problems, valuable and perhaps brilliant achievements would follow.

Among the interesting features of recent practice abroad are car suspensions designed to secure riding-comfort on rough roads and front-end drives that are intended to improve road adherence. Automatic and continuous transmissions, such as those produced by Constantinesco, Fieux, Renault and Soden, were shown also.

Other illustrations were those of various systems of supercharging and the development of two-cycle engines to improve power-output and secure engines of less cost or of lower speed. Air-cooling and streamlining methods and types of engines suited for burning heavy fuel also received their proper share of explanation and comment from Professor Norman, his contribution of data of this nature having been replete with inspirational features of great potential value.

TWO NEW ENGLAND SECTION MEETINGS

A Special Type of Spring and Recent Air-Mail Operations Described

Riding-quality and to what degree it is bettered by using the fulcrum spring made by the company represented by H. W. Hyde formed the subject of the paper he presented at the Oct. 8 meeting of the New England Section held in Boston. He traced the development of this type of spring and enumerated its claims for advantage. The paper was well received and was followed by a lively discussion. About 35 members and guests were in attendance.

At the meeting of this Section held at Springfield, Mass., Oct. 22, E. P. Warner, associate professor of aeronautical engineering at the Massachusetts Institute of Technology, presented his informative paper on Commercial Flying with Mail and Passengers. He made comparisons between American and European aeronautic enterprises and described the recent operations of the United States Air-Mail Service.

LESSONS FROM AIRCRAFT PRACTICE

Authoritative Information on Recent Lines of Air-Service Achievement

World-flight data were presented, some of the lessons it taught were stated and recent supercharger development was reviewed in the informative and authoritative paper presented by E. T. Jones, chief of the powerplant section, engineering division of the Army Air-Service, to the members and guests of the Chicago Section who assembled at the meeting held Oct. 23. Mr. Jones has direct supervision over the engine-development work that is being done by and for the Air-Service, at the experiment station at McCook Field, Dayton, Ohio, and at the plants of various engine builders,

Schedule of Sections Meetings

NOVEMBER

4—BUFFALO SECTION—Fatigue of Metals—Prof. H. F. Moore

5—NEW ENGLAND SECTION (Boston)—Storage-Battery Problems of the Motor-Car Dealers—T. H. Dooling

12—DAYTON SECTION—The Automobile from the Insurance Underwriters' Standpoint—C. R. Alling

13—DETROIT SECTION—How Aviation Engines Are Adapted to Speed Boats—Gar Wood

13—INDIANA SECTION—Flow of Heat in Pistons—Prof. H. A. Huebotter

14—WASHINGTON SECTION—Air-Cleaners—L. L. Dollinger

19—NEW ENGLAND SECTION (Worcester)—Abrasives and Their Use—Representatives of Norton Co.—Plant Visit in Afternoon

21—CHICAGO SECTION—Cold-Weather Operation of Motor-Cars—Ignition, Battery and Electrical Problems—J. H. Hunt; Carbureter, Manifolding and Fuel Problems—O. C. Berry

DECEMBER

2—DAYTON SECTION—The Cab and the Motorbus: Their Operation, Maintenance and Design—Joint Meeting with Engineers' Club

11—INDIANA SECTION—Aviation Development—Major E. L. Hoffman; Superchargers—Dr. F. A. Moss

15—CLEVELAND SECTION—Development of Clutches—Ernest E. Wemp

16—BUFFALO SECTION—Work of the Bureau of Standards—Dr. H. C. Dickinson

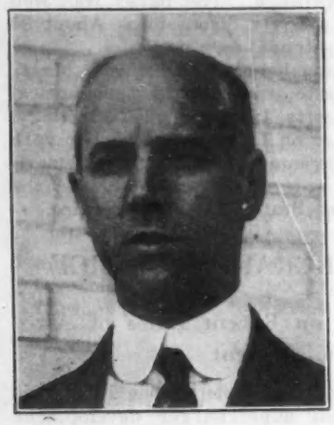
and is also a leading authority on the subject of supercharged induction.

Included also were data relating to the new air-cooled Liberty Engine, to new bearing metals and to special methods of valve cooling. Pictures illustrated the recent activities of the engineering division of the Air-Service.

When it is remembered that the practical development of such important features as full pressure-lubrication, anti-knock fuels, forced water-circulation around valves, aluminum pistons, silchrome valves and supercharged induction is directly due to the development work done on aircraft engines, the value of the information made available to those in attendance can be realized more fully.

IS HYDRAULIC STEERING COMING?

Wheel Shimmy Meeting of Buffalo Section Reveals This Possibility



J. E. HALE

Wheel shimmy, wheel wabble, gold-fishing or whatever one wishes to characterize it, is opening the way for some radical automotive engineering developments in the near future. There is the possibility that cars will not only be braked by hydraulic means, but that this principle will be employed to steer them as well. If the actual steering motion is not controlled by hydraulic pressure, at least there is the possibility that hydraulic dash-pots or dampening devices will be used to resist any tendency of the front wheels to shimmy. These and many other less radical panaceas for wheel wabble were revealed at an intensely interesting meeting of the Buffalo Section last month. Over 200 men attended the meeting and many of the representative car companies sent engineers to hear the discussions. The subject was introduced by some rather spectacular road demonstrations of wheel shimmy in the afternoon. In one of these, a shot-gun was discharged into one front tire of a car while running at a speed of 45 m.p.h. The balloon tire almost left the rim, but the driver experienced no difficulty in controlling the car with only one hand on the steering-wheel. This demonstrated that balloon-tire blow-outs are not necessarily dangerous provided the steering layout is properly selected. Other demonstrations showed the skeptics in a most convincing fashion that there is such a thing as wheel wabble and that it represents one of our most pressing engineering problems. The demonstrations were arranged by the Goodyear Tire & Rubber Co. and the Budd Wheel Co.

James E. Hale, balloon-tire paternalist, gave a very comprehensive analysis of the wheel-shimmy problem in the evening meeting. R. B. Day of the Goodyear Tire & Rubber Co. and E. J. W. Ragsdale gave their versions of wheel-shimmy causes. A. J. Baker, Overland chief engineer; F. F. Chandler, Otto M. Burkhardt and several others were active in the discussion. A complete report of the discussion will appear in an early issue of THE JOURNAL. Meantime, the following abstract gives the salient points.

REVERSAL OF FRONT-SPRING MOUNTING REDUCES SHIMMY

There is little question that wheel wabble is aggravated by balloon tires with their lesser stability. In a majority of cases the primary cause of the condition is bad steering-linkage geometry; that is, the respective arcs of travel of the steering-arm ball and the front end of the steering-gear connecting-rod deviate too much from a common path. This error can be almost entirely corrected by reversing the mounting of the front spring, putting the shackle at the front end and the fixed point at the rear. In this case the two arcs will be nearly concentric. It is not unlikely that cars will soon appear on the street with this radical departure from conventional design incorporated in them. Once set up, wheel shimmy persists for an appreciable time before it can be dampened out. This has led to experiments with hydraulic dashpots connected to the steering cross-rod in such a way as to resist rapid oscillation of this member. The device functions in a manner similar to the conventional hydraulic door-check. Goodyear has done considerable experimenting with such a device but it is still in the development stage. However, its advantages have been clearly demonstrated.

To eliminate all effect of non-concentric arcs of travel of steering-knuckle and connecting-rod ends, there is the possibility of employing hydraulic means for transmitting the motion from the steering-wheel to the road wheels. Apparently many investigators are working along this line. Mr. Hale has experimented with such a scheme successfully. One maker is working on an arrangement where turning of the steering-wheel operates a gear pump that communicates with a cylinder and piston on the front axle. Movement of this latter unit causes the front wheels to move in either direction depending on which side of the piston is under pressure.

SHIMMY PROBLEM DIVIDES INTO TWO DISTINCT PARTS

The meeting brought out the importance of dividing wheel-wabble troubles into two distinct problems. First, there is what may be characterized as gold-fishing which is a wiggle or rapid oscillation of the wheel about the steering-knuckle axis. Another trouble, entirely distinct from this, is the rapid bobbing up and down of the wheel which was called tramping by Mr. Ragsdale. Steering-layout geometry and play in the system are largely influential in the first phase, but the latter problem is more nearly related to spring design and tire resiliency. The Goodyear representatives said that they had succeeded in controlling the wabble with the hydraulic check and the tramping with suitable vertical shock-absorbing devices.

From the general discussion it was evident that engineers are still far from agreement on such questions as soft or stiff front-springs, inclined or vertical steering-pivots, number of tire plies, importance of perfect wheel and tire balance, influence of gyroscopic forces and relative resistance to puncture of balloon and high-pressure tires.

SERVICE PROBLEMS AT CLEVELAND

National Automobile Chamber of Commerce to Co-operate in Meeting This Month

Next in line on the Society's national meeting program comes the Service Meeting at the Winton Hotel, Cleveland, Nov. 18 and 19. This 2-day gathering will bring together the men from the motor-car plants and the distributor and dealer organizations who specialize on the technical phases of automotive service. The program is being arranged under the joint direction of the Society and the Service Committee of the National Automobile Chamber of Commerce, of which Alvan Macauley is chairman. While the selection of speakers on the specific topics is not ready for announcement, the topics themselves can be disclosed. General merchandising policies related to service sales will be covered in one paper. This will touch on the importance of proper pricing of parts and operations to compete with the unauthorized parts and repair agencies. Intensive study of flat-rate operations that are performed with greatest frequency will be recommended. A paper on the advisability of putting more engineering into repair and maintenance work will also be presented. Pyroxylin finishes, balloon-tire problems, four-wheel brakes, fuel tonics or dopes, oil dilution and many other equally important matters will be treated.

Formal announcement of the program as finally selected will reach the membership about Nov. 10 through the medium of the *Meetings Bulletin.*

METAL SEAPLANE FLOATS ARE BEST

Other Interesting Points Brought Out at Dayton Aviation Meeting

COM. H. C. RICHARDSON, U. S. N.

Many of the latest developments in Naval aircraft were revealed at the Aeronautic Meeting that was held in Dayton on Oct. 2 under the joint auspices of the parent Society and the Dayton Section. While the discussion was a general one, suitable means of flotation for over-water aircraft seemed to be the problem of greatest interest to the aeronautical engineers present. The informative paper that was presented by Com. H. C. Richardson of the Navy Air Service and that is printed in full starting on p. 412 of this issue of THE JOURNAL served as a basis for an active discussion of all-metal float construction and the relative advantages of single and double floats. In addition, the members had the privilege of hearing an interesting informal talk by C. G. Grey, personable editor of the British publication, *The Aeroplane.*

Mr. Grey said that he had been particularly impressed during his visit to the National Air Races at Dayton by the large number of independent or "gypsy" fliers who had flown ships of conglomerate design from distant points to participate in or witness the contests. He had never seen anything to equal the volume of independent flying that is being done in this Country. "These people of yours all seem to have their own distinct engineering ideas," said Mr. Grey. "Each man has his own notion of what an airplane ought to be like and how it ought to be put together. It reflects the mechanical ability and keenness of American aviation enthusiasts, and from that, civil aviation is going to develop."

The British have carried on a limited amount of development in large flying-boats, according to Mr. Grey. Their largest ship of this type is powered with four engines developing an aggregate output of 700 hp. British engineers have been somewhat skeptical of duralumin as a metal for over-water craft. As Mr. Grey put it, they did not trust it within smelling distance of salt water. However, he believes that the metal hull and the metal float hold the ultimate solution of waterlogging problems. All-metal construction of airplanes is coming forward rapidly in Europe. The work in England has been largely along what Mr. Grey characterized as steel lattice-work lines. He thinks that the development has been influenced too much by wooden construction practice. Wooden members have simply been replaced by metal members instead of evolving a structure that is essentially an all-metal one.

RELATIVE MERITS OF CENTRAL AND WING FLOATS

Replying to a question put by Mr. Grey, Commander Richardson said that the Navy engineers prefer single central floats to double wing-floats for seaplane service because experience with the fleet at sea has proved this construction to be superior. With the central float, all principal weights are concentrated directly over the point of flotation and all loads are carried directly to the hull without stressing the wing structure. In a bad seaway, wing floats subject the entire wing structure to severe racking strains. Mr. Grey said that the British navy has experienced no trouble with twin-float machines and that not a single central-float seaplane was being used in England. Considerable experimenting has been done with amphibious planes and these utilize twin floats with a wheel beside each float. The present tendency is to use a single high-powered engine rather than two smaller engines for driving British seaplanes. A difference of opinion still prevails as to which engine is superior, water-cooled or air-cooled, and the air-cooled engine advocates are undecided whether the two-row or single-row engine is best. Mr. Grey said in his inimitable way "it is largely a question of whether you prefer a chrysanthemum or a sunflower."

Commander Richardson said that the construction cost of metal floats is the one great obstacle in the way of their general adoption. At present a metal float costs in the neighborhood of $7,000 whereas a wooden float of the same size can be built for $900. The great difference is not due to the relative costs of the materials, but results from the magnitudinous riveting job necessary to make all joints watertight. As reported in his paper, Commander Richardson said that welded joints are impractical since the untempered metal at the joints corrodes excessively when immersed in salt water.

NATIONAL MEETINGS CALENDAR

SERVICE ENGINEERING MEETING—Cleveland—Nov. 18-19

MOTORBOAT MEETING—New York City—Jan. 7, 1925

ANNUAL DINNER—New York City—Jan. 8, 1925

ANNUAL MEETING—Detroit—Jan. 20-23, 1925

THE CARNIVAL—Detroit—Jan. 21, 1925

Catapulting of Airplanes Affects Carbureter Action

Some difficulty has been encountered in catapulting airplanes from ships at sea due to the great acceleration of the plane affecting the action of the liquid fuel passing through the carbureter. In some cases the mixture is enriched for an instant and in others an apparent starving effect is noticed. The Navy engineers are not certain as to which factors are responsible for the trouble, but the problem is receiving intensive study.

Some discussion was had on the matter of the Navy spending large sums of money to study the design, construction and operation of large rigid airships such as the Shenandoah. W. H. Barling expressed the opinion that the money might better have been spent for experimental work on heavier-than-air craft. His opinion did not receive support from H. M. Crane, J. H. Hunt and Ralph Upson. The first two of these three men took the stand that it is the duty of the Navy to investigate the lighter-than-air craft on its own initiative, not depending upon foreign nations and engineers for experience that would be invaluable in case of war. They believed the money had been well spent.

Dr. G. H. Madelung spoke briefly on the advantages of all-metal airplane construction.

THE PRODUCTION MEETING

Detroit, Oct. 22 to 24

REDUCE WASTE AND CUT COSTS

Manufacturing Economies Hold the Center of the Production Meeting Stage

Reduction of manufacturing costs seemed to be the key note struck at the Production Meeting of the Society in Detroit, Oct. 22 to 24. No matter whether a particular paper discussed a new production process, an improvement in an old one, or indicated how waste material or time might be conserved, lower costs seemed to be the primary object in mind. The trend of all discussions was toward means of cutting labor, tool or material outlay. Taken as a whole, the papers and discussions were a valuable contribution to the literature of production engineering. It will pay any production executive to read through the account of the several sessions which appears on the following pages. Many of the papers are printed in full in this issue of THE JOURNAL and the remainder will appear in an early number.

Great interest was shown in the Hudson scheme of striking flat surfaces in a coining press rather than milling or spot-facing them. The discussion at the Labor and Wage Session indicated that time-study men are nearly in agreement that the group-bonus plan is the ultimate solution of wage-incentive problems. The Shipping Session recorded the fact that all factories have had difficulty in shipping cars that rested on balloon tires when in transit. Over-inflation of the tires while the car is en route seems to be the solution agreed upon. Those who enjoyed the Glass Session paper and discussion seemed most interested in glass inspection and imperfections, although the Ford method of making glass by the continuous process elicited much comment.

Specific remedies for wood checking were presented in the Lumber Session and efficient methods of lumber handling were described. Bonus payment to tool-makers at the Paige plant seemed to draw the lion's share of interest at the Tool Design Session. Here again, the reduction of manufacturing costs was emphasized. One of the liveliest discussions during the Production Meeting developed in the Plating Session. It is very evident that great progress has been made in nickel-plating by all manufacturers. Parts that could not stand up in a salt spray for more than 2 or 3 hr. under the old practices can now withstand this severe test for 24 hr. Listening to the papers on factory maintenance, one got the impression that slip-shod methods of supervision which result in loss of time by millwrights and other plant labor are things of the past.

While the attendance at this year's Production Meeting did not equal the figures of previous years, the meeting was a success. What it lacked in numbers was more than offset by the interest shown in each of the sessions.

MODERN PRODUCTION METHODS

Machine-Shop Economies and Coining-Press Utility, Topics of Opening Session

Each improvement in methods of machine-shop production tends to bring into prominence other possibilities of betterment which, without the effect of contrast, would in many instances pass unnoticed. Only by extremely careful analysis and research can the greatest potential economies be brought to light.

R. M. Hidey
White

John Scott
Oldsmobile

E. W. Karlson
Cleveland

A. U. Widman
Cadillac

SOME FACTORY EXECUTIVES

A. L. DeLeeuw, consulting engineer and consulting editor of the *American Machinist*, in his paper on Possible Economies in Automotive Machine-Shop Operations, emphasized the above points and presented a wealth of practical material at the opening of the third annual production session of the Society. The paper is printed in full, beginning on p. 418 of this issue of THE JOURNAL.

The paper served to bring forth much valuable discussion from outstanding figures in the automotive production field. Among the contributions was a very interesting report of activities at the Charlottenburg Technische Hochschule by Dr. Georg Schlesinger, professor of engineering at that well-known institution. Dr. Schlesinger recommended the careful inspection of drill grinding machines, to assure proper characteristics of the drills that come from them. As a labor and time-saving measure, be believed this practice superior to the inspection of every drill. Slides were used to illustrate machines and methods that have been developed in Germany under Dr. Schlesinger's supervision to test both drills and machines. The latter included an apparatus for studying the turning moment and vertical force that accompany the process of drilling on a vertical machine. The investigation that led to these developments included many determinations of turning moment and "crushing power" for different types and sizes of drill working in a number of metals.

Dr. Schlesinger gave a very interesting account of the relations that exist between the Technische Hochschule and the government and industrial organizations in Germany. He concluded this discussion with a statement concerning a new light-weight magnesium alloy developed in Germany that he believed would soon fill a very important place in the automotive field. The composition of this alloy was said to be 90 per cent magnesium, 8 per cent zinc, and the remainder lead and tin. Attention was called to the fact that new machines should be developed for properly working the light alloys. High speeds and other conditions of operation require special designs for most efficient service. The extended use of ball and roller bearings was forecast.

Eugene Bouton, supervisor of time study, Chandler Motor Car Co., called attention to the fact that different point-thicknesses and angles are required for drills assigned to different types of work. The drill as it comes from the manufacturer may be made to perform best on a given job by properly shaping the point to conform to the specific requirements of the work at hand.

In answer to a question from Mr. Bouton, Mr. DeLeeuw stated that the time set in a shop for a given operation or the production required from a given machine is most often established on information of doubtful reliability, the "say so" of the shop foreman. Data ascertained by fundamental research were advocated as the proper basis for the setting of such factors. Mr. DeLeeuw further emphasized the tendency to gage production requirements upon least favorable rather than upon average capabilities of tools and machines.

Mr. DeLeeuw recalled the reference of Dr. Schlesinger in regard to the possibility of power savings by setting suitable standards of tool performance. He called attention to the fact that each horsepower expended in turning a dulled or improperly formed tool is used to bring about complete ruination of the tool.

Earle Buckingham discussed the relative efficiencies of magazine and hopper feed. He stated that in his experience the hopper feed had been found to give from 10 to 20 per cent less production than the magazine feed.

KELSO ON COINING-PRESS OPERATION

Following the presentation and discussion of the paper referred to above, A. R. Kelso, Hudson Motor Car Co., gave an address on Coining-Press Operation. It is printed in this issue of THE JOURNAL, commencing on p. 399. In discussing Mr. Kelso's paper, Eugene Bouton further emphasized the possibilities for great savings in production by the use of the coining press; he also predicted a rapid adoption of the machine in many lines of automotive work.

It was stated that in the work outlined by Mr. Kelso the

A. R. KELSO

A. L. DELEEUW

faces of the dies do not come together and that the ram adjustment is capable of holding the work within suitable tolerances. In confirmation of this point a sample was shown of two connecting-rods that by mistake had been fed into the machine together and superimposed. The two rods were amalgamated by the squeezing process. The interesting point was that the final combination came within the tolerances specified for a single piece.

Mr. DeLeeuw stated that in cases where the work is small and the tolerances come within 0.0005 in., it is necessary to have the die faces meet. In this type of work the thickness of a film of oil that may form in the dies is an important factor. For work on thin pieces, the required unit area pressures were said to increase enormously as the thickness of the piece decreases.

The speaker called attention to the existing lack of agreement regarding ratings of coining presses. He believed that the Society might well undertake to bring about a standard method of specifying the rating. It might be possible, for example, to state that a given press exerts a force of 400 tons when the crank or toggle is at a certain point in the cycle.

Mr. DeLeeuw compared the hydraulic and toggle types of press and called attention to the disadvantage of the slow operating-speed that characterizes the hydraulic type. While the toggle type is capable of higher speeds, it ordinarily lacks the capability possessed by the hydraulic type of limiting the maximum force applied by the press. The speaker mentioned his work in designing a combination toggle and hydraulic machine in which the advantages of both types are present.

Dr. Schlesinger reported that this desirable feature of safety to the press has been brought about in Germany by an electrical arrangement that automatically cuts out the operating motor at the instant when excessive forces prevail.

Mr. Kelso spoke of the practice of straightening clutch discs with the coining press and thus effecting a large saving in labor cost. He believed that the discs could be properly squeezed to thickness as well as straightened with a machine of sufficient capacity. Mr. DeLeeuw suggested the possibility of straightening the discs in quantity by pressing them in stacks in a hydraulic press. Mr. Kelso believed, however, that the necessity of flowing the metal to straighten the parts properly would eliminate this possibility.

Mr. DeLeeuw spoke of the opportunity to increase production by the use of multiple dies in each machine. Chairman Younger cited an example of coining-press use in the process of briquetting. A number of interesting points were brought out by Mr. Kelso in his replies to questions from the floor. Malleable iron parts can be coin-pressed as well as forgings. The coin-pressed malleable iron presents a better finish than is found on the squeezed forgings. Fractures will usually result when more than 1/32 in. is left for squeezing. Parts to be coin-pressed are usually given the same heat-treatment as would be used before machining. Coin-pressing is done

on the cold metal. With the dies open in their terminal position, a limit of 0.002 in. is practical. Where limits are closer than this, the faces of the dies must meet at the terminal point. A connecting-rod, for example, can be coin-pressed to satisfy the 0.002-in. limit. Greater dimension changes accompany heat-treatment after coin-pressing than after machining. Coin-pressing has been found to give satisfactory results on parts case-hardened by the cyanide process. No data were at hand to show the effect upon parts having a thick "case."

The opening meeting of the Production Session above reported was under the very able chairmanship of John Younger, who set the pace for following meetings by opening *on time.*

COMPENSATION AND COOPERATION

Group-Bonus Wage Plan and New Phases of Welfare Work Receive Attention

E. K. WENNERLUND

Almost unanimous approval of the Group-Bonus Wage Incentive Plan was voiced by those who attended the Labor and Wage Session. A description of the experience of the Maxwell Motor Corporation since the introduction of the plan into its shops was first given by H. G. Perkins, one of the company's production engineers, whose paper is printed in full on page 464 of this issue of THE JOURNAL. A lively discussion followed in which representatives of the Hudson, Cadillac, Chandler, Continental Motors, Kleinert Wheel, Kelsey Wheel, and other companies took part.

Mr. Perkins emphasized particularly the fact that increasing the incentive of employes produces more desirable results than does the flat-rate or the day-rate method. In the Maxwell Motor Corporation, he said, the group wage-payment plan had proved very successful, notwithstanding failures at first in two or three departments, because of neglects in conforming to certain fundamental requirements that were afterward proved to be essential.

In opening the discussion, N. G. Shidle inquired further regarding the failure of the system in the crankshaft department and was advised that unsuccessful operation in that case had been due merely to a faulty method of application of the fundamental principles.

To Eugene Bouton's query concerning the relative amounts of work necessary to prorate the earnings in the group-bonus and in the piecework systems, Mr. Perkins replied that in the group-bonus system it was not so difficult to recognize differences in the ability of the workman as in the piecework system. In the crankshaft department 40 men quit work when the system was first installed. Trouble also occurred sometimes when the wages of certain members of a group were increased. When a man is given a raise the group piece price does not increase. The count is the basis of both piecework and group work. A check on production is kept by the amount of stock issued.

To John Younger's question regarding the operation of automatic screw-machines, Mr. Perkins stated that one man might operate several machines, and through a formula is developed a coefficient of production. Bonus is based on count rather than quality, but the number of rejections is made note of. So-called job setters are part of the group.

OPERATING ALLOWANCES

In case of tool or material troubles, what are called "operating allowances" are made by the foreman. Where production is decreased owing to unsatisfactory conditions an allowance is made. When the gang is idle the men are paid a straight day-rate wage. As regards the discrimination given to the older men, he said that if they were not better they would not have been with the company so long. The normal turnover removes the inefficient ones. When men employed only a short time and those employed longer do the same amount of work, it becomes a matter for the judgment of the foreman. Costs can be reduced by taking advantage of the labor situation and hiring men at lower prices.

Mr. Mitchell, of the Hudson Motor Car Co., remarked that that company pays the men per finished piece and that the cost determination merely totals the several costs. Mr. Perkins replied that costs in the group-bonus system are not affected by efficiency but remain the same regardless of efficiency. Cost merely tells whether the men are performing according to their efficiency. Continuing, Mr. Perkins said that an additional advantage lay in the ease of distribution and in the granting of raises. These are largely a question of policy. Based on the principle of equal pay for equal work, said Mr. Bouton, rewarding an old employe must be done in some other way than by a difference in rate.

The route sheet in the shop carries the time, continued Mr. Perkins. In most shops, in order to change the piecework rate, large numbers of route sheets must be changed. The guarantee is in the time, not in the pay rate. Day rates are adjusted to meet the labor situation. The basic rates must be determined and are classified periodically. The group method is not applied to die and tool-makers. Most of them work on a flat rate per day. When the guarantee periods are established during which the rates will not be changed, he said the company is very frank in telling the men to "make all they can while they can."

DAY AND NIGHT SHIFTS

Replying to Mr. Sheeting, of the Continental Motor Corporation, Mr. Perkins said that in certain departments it is possible to separate the production of the day gang from that of the night gang. The day shift and the night shift men are made members of one group. Some of the better men, consequently, are put on the night shifts and get a bonus. In a period of peak production the men will not carry a slow man along, but they will carry a new man until he shows his ability. So long as unskilled men maintain 100-per cent efficiency the costs are standard, and it is questionable whether the standard will be lowered.

Replying to Mr. Stewart's question whether any place had been found where the group-bonus system has had to be taken out and the department put back on piecework, Mr. Perkins said the group-bonus system is not installed unless it is expected to be successful. The company does not give ground once it has determined to use the system. Out of between 300 and 400 groups in which the system has been installed only 2 have proved unsuccessful, during the 2 years of its operation. When men cannot keep pace no instances of bodily injury have occurred, a good "razzing" being usually sufficient to speed up the slow ones.

Comparing the relative percentages of the bonus and the day rate, Mr. Perkins said that a high day-rate is desirable. A bonus is not given entirely for production but for recognition of service. The rate of pay is a good average rate, and the best percentage of bonus had not been determined.

SMALL GROUPS MORE EFFICIENT

As a general rule small groups are better and more efficient. The men work together better. The engine-assembling group consists of a half dozen sub-assembly groups. In the final assembling group as many as 60 men will be found; the average number in a group is about 10. When a piece is rejected in the inspection because of faulty workmanship it is sent back in the line and goes through again.

Employes are not held responsible for defects for which a vendor is responsible, but the men are given credit for so many pieces just as if the pieces were good. Overtime is a matter of company policy and is about the same no matter what system is in vogue.

Chairman E. K. Wennerlund expressed the opinion that the tendency of the industry is distinctly toward the grouping of employes, because it works well and at the same time cuts down clerical work.

Mr. Kleinert, of the Kelsey Wheel Co., said that their reason for adopting the system was to standardize production.

F. O. Clements, of the Cadillac Motor Car Co., asserted that this company had been more than pleased with the workings of the group system. In his opinion, one of the advantages that is to be derived is the saving of floor space. Departments do not take so much space, for it is not necessary to store so much material in the department. Because of the increased production the material goes through the shop quicker than before. It is not necessary to have a supply of stock ahead of each operation. The group system is being tried not only in the productive department but in the non-productive. The amount of labor necessary for handling stocks has been reduced from 35 to 40 per cent. This means decreased cost for the amount of material handled.

According to Mr. Carson, of the Cadillac Motor Car Co., the men seem satisfied and the results seem to be about the same in both the group and the piecework systems. Some of the older men had to be displaced at first, but now the men are well pleased.

Sweepers on Bonus System

Mr. Ford, of the Cadillac Motor Car Co., testified that all the sweepers work on the bonus system. The labor has been reduced about 40 per cent.

The General Motors plants, said Chairman Wennerlund, are using standard time. Some may differ and prefer piecework. But money must be divided up somehow. The group method is best in large assembling operations, said Mr. Bouton, of the Chandler Motor Car Co., and also in the machine shop for such operations as the assembling of the transmission. Employes are rated according to their occupation or classification. A highly skilled man gets a higher rate than the less skilled employe, but the result is the same. The principal difference is that no calculation is necessary. The workman knows exactly what he will get. The employer will get a certain amount of work for a certain given sum of money. A few operations are still on the piecework basis, such, for example, as drilling of holes when one day's labor will produce enough for a week's work.

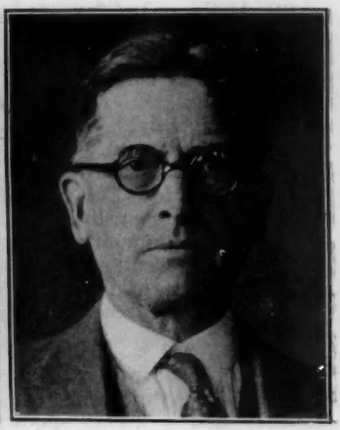
Mr. Mitchell, of the Hudson Motor Car Co., declared that his department was on a 100-per cent group piecework basis. The crankshaft department has been one of the hardest to control; but the group system works well whether used with either bonus or time system.

Mr. Widman, of the Cadillac Company, said that a year ago the company was surprised at the results obtained by the group-bonus system. The men liked it better and the company likes it better.

Mr. Ford, of the Cadillac Motor Car Co., found that with the group-bonus system the earnings of the men could be prorated better than with the piecework system. Previously they had discovered considerable slack in the lines of the assembling department. When a man finished his work he was frequently found sitting along the wall. That has been done away with by the group-bonus system. Day workers have been dispensed with. The foremen are the only men who still have the day rate. Most of the non-productive departments had been working at about from 50 to 75 per cent efficiency. The group-bonus system has already been installed in between 50 and 60 per cent of the departments. The crankshaft department will be the next. The entire plant is expected to be changed over completely within a year.

The Continental Motors Corporation, said Mr. Sheeting, has installed the complete group piecework system in every department. The result has been that the number of hours required for the completion of an engine has been reduced, the scrap has been reduced and the earnings of the men increased.

H. G. Perkins



C. A. Lippincott

As regards accounting, asserted Mr. Carter, of the Cadillac Motor Car Co., the group-bonus system makes a very clean-cut procedure for payroll and cost work. Arriving at costs can be done very quickly.

Cooperation

Cooperation rather than welfare work, which savors of paternalism and tends toward socialism and communism, was the keynote of the spirited address by C. A. Lippincott, of the Studebaker Corporation of America. Declaring that welfare work is neither ethically nor economically sound, the speaker argued that inasmuch as we live under a representative form of government our industrial institutions should conform to the principles of our political organization.

Experience has demonstrated, said Mr. Lippincott, that industrial prosperity depends upon industrial peace. Industrial peace depends upon confidence, confidence of managers in their men and of men in their managers. Confidence develops cooperation. Cooperation is essential to success. Human relations are the fundamental problem of all organized effort. This begins in the home and is at the bottom of all commercial and industrial organizations. Various efforts have been made to secure the good will, loyalty and cooperation of employes. Welfare plans flourished extensively at the close of the war, but they are based on the bestowing of gratuities, something for nothing, and some form of paternalistic control. Accepting gratuities destroys the moral fiber that constitutes the essence of character. Paternalism undermines the independent individuality that laid the foundations of this Nation and made it great. The self-respecting man says, "Give me what is due me and I will look out for my own welfare." Paternalism tends directly toward socialism, which would take away industry, intelligence and incentive from those whose efforts have enriched the world and give nothing to him who now has nothing.

Welfare Plans Abandoned

Welfare plans flourished during a period of great prosperity; they were dropped when the slump came because they were not economically sound. Henry Ford, who has done much for his employes, has abandoned his extensive welfare plans.

Working men are chiefly interested in fair wages and fair working conditions. Five years ago the Studebaker Corporation of America adopted its cooperative plans for employes, the object sought being their continuous service, loyalty and good-will.

The plans include:

(1) An anniversary wage or dividend. This amounts to 5 per cent of the employe's yearly earnings at the end of each year up to the fifth; thereafter it is increased to 10 per cent for his period of service

(2) At the end of 2 years he receives 1 week's vacation with pay
(3) He may buy stock in the corporation at a few points below the market, on which he will receive the regular dividend and 50 per cent additional
(4) At the age of 60, if he has been in continuous service for 20 years, he is eligible to a pension for life. This amounts to 25 per cent of his average earnings for the preceding 5 years, with the minimum of $30 per month.
(5) In the event of his death, if he has been in the service of the Corporation for 5 years, his dependents receive $500

ADMINISTRATION

Although these provisions cost the Corporation more than $2,000,000 a year, they are justified by the increased efficiency and a higher quality of production. They are administered by a department created for the purpose, and having in charge all the employe's relations with the Corporation except the supervision of his labor. The advantages of the plan are (*a*) that the problems of management remain in the hands of the men who are qualified to solve them, and (*b*) that the good-will of the man is secured by fair treatment.

Men, machinery, materials and methods are the four factors in production. Millions have been spent on the last three, but the final result depends upon the men. In the past the foreman has been practically the only point of contact between the men and the company. Men will follow a humane leader with enthusiasm but will "buck" a driver. Now, no man can be hired or discharged except by the special department that has charge of his relations with the Corporation. To it the employe can go directly at any time. Foremen are educated to be directors, not drivers. The effort to secure cooperation is based on justice in the distribution of men, management and capital. The best asset that any employer can have is the good-will, loyalty and cooperation of his men. He can well afford to devote his best thought and energy to this problem.

In the discussion, in response to a query by Mr. Carter, Mr. Lippincott explained that although men could retire on a pension at 60 some had to be induced to do so. The foremen represented the men in all conferences with the managers and division superintendents, with regard both to wages and to working conditions.

BALLOON TIRES AFFECT CAR SHIPMENT

Other Car-Loading Problems Receive Study in Production Meeting Shipping Session

Hard steering, wheel shimmy and rapid tire-wear are not the only problems for which the balloon tire can be held responsible. Even the traffic department of the car manufacturer has had his troubles with the flabby cushions of low-pressure air. Greater motion of automobiles loaded in box-cars results from their being shipped on balloon tires and this has introduced heavier blocking and caused the tires to chafe badly if proper precautions are not taken. Ben Moore's very interesting paper on automobile shipment, which set forth the materials and methods used at the Dodge Bros. plant, served as the basis for a helpful discussion of several other shipping problems at the Shipping Session of the Production Meeting in Detroit. An abstract of his paper and the remarks made during the discussion follow.

V. P. RUMELY

B. R. MOORE

First among the operations of car loading is the cleaning of the box-car after it is placed on the siding. This in itself is no small item, for in the case of Dodge Bros. it costs in the neighborhood of $1,000 each month. Sometimes it is necessary to cover the floor of the box-car with paper if the previous shipment has been lime, cement, plaster, coal, hardening compound or similar material, the dust of which is harmful to automobile finish. Often the box-cars must be repaired. If the shipment is to pass over the desert land in the West, proper precaution must be taken to protect the car finish from alkali dust.

After passing final inspection, the automobiles are turned over to the traffic department, all gasoline is drained and the models are distributed according to consignments. Blocking, decking and loading devices are distributed at the same time. Tools, lamps and small parts are packed in cartons and distributed along with the automobiles. Upon arrival at the freight-car, each automobile is stripped in accordance with the plan of loading determined upon. Batteries are disconnected, water drained, springs clamped, open-car tops folded and stowed, windshields removed and packed in crates, and nuts, washers and small parts put in a small bag securely fastened to each machine. If the cars are shipped one above the other, the wheels are removed and their bearings washed, greased and packed in small boxes. The engine oil is drained if the automobiles are "half-decked." Caution cards are attached in a prominent place to all closed-car shipments, giving instructions regarding the proper handling of the car when it is unloaded. A paper drip sheet is placed under the oil-pan of all cars shipped double-decked or half-decked.

Shipments are termed "double-decked" when both ends of the upper automobile are supported on wooden stilts in the freight-car to provide clearance for another automobile underneath. In loading Dodge cars, the supporting wooden members are arranged so as to place the entire resistance to shifting of the load on the rear construction of the automobile, as this is where it is best adapted to withstand the shocks set up in transportation. When a shortage of box-cars exists and it becomes necessary to load on flat-cars or gondolas, a steel tripod that Dodge Bros. have developed is used to support the end of each axle, since there are no side walls to which wooden supports can be nailed. A shipment is termed "half-decked" when only one end of the automobile is raised off the car floor, this usually being the front end, since the greatest clearance underneath is obtained in this way. The supporting members in this case are similar to those used under the rear axle of cars in a double-decked shipment.

Cars loaded on the freight-car floor are fastened with metal straps running over the axles, when disc wheels are used, and by rope running through the wheels when wooden wheels are fitted. The wheels are chocked fore and aft with grooved blocks that fit the contour of the tire and keep the wheel properly aligned.

After loading, all shipments are subject to four distinct inspections. First, a traffic-department record is made of the engine number and the numbers of any detached parts. Second, a traffic-department inspector tests and approves all bracing and blocking. Third, a representative from the sales department inspects and records the condition of the cars and parts, rejecting items that will not pass inspection, and these must be replaced or repaired. Finally, a sales-department inspector makes certain that the items noted during the third inspection are taken care of; then he seals

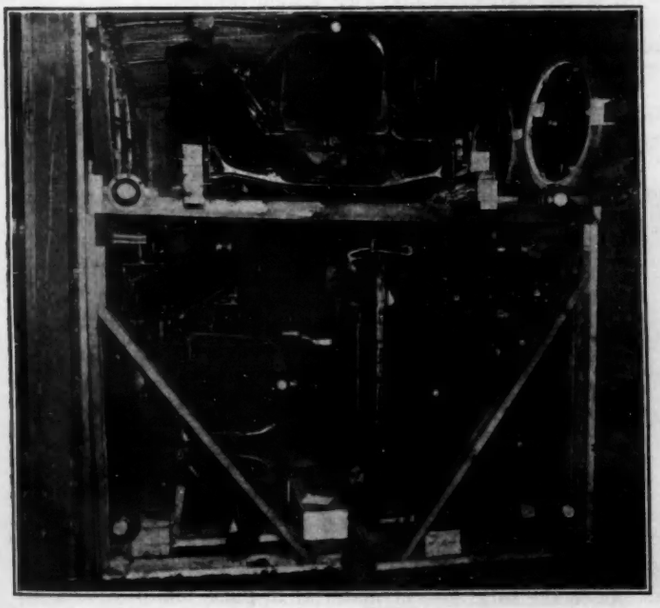
the car doors. After checking all inspection records against assignments and bills of lading, the box-cars are carded and hauled away.

Mr. Moore gave a brief description of Dodge practice for boxing foreign shipments. This will be presented in the full printing of his paper in an early issue of THE JOURNAL. He said that over 24,000,000 ft. of lumber is used annually for the shipping of Dodge cars. Over 1,250,000 lb. of nails is required, as well as enough paper to reach from Detroit to Boston. As evidence of the care and thoroughness used in preparing cars for shipment by rail, Mr. Moore quoted figures to the effect that only 4.1 per cent of the loss and damage account on 216 American and Canadian railroads for one year was charged against motor-car shipments.

After seeing the compact way in which the automobiles were stored away in the box-car, L. L. Williams remarked that it looked easier to load than unload them. Mr. Moore admitted the truth of this but said that Dodge Bros. had selected recommended types of chain-falls and dollies for use by their dealers and that only the dealer in the small town encountered any real difficulty in this respect. He said that the railroads should equip automobile cars with movable eye-bolts or lugs fitted in the roof of steel-roofed cars. At present, Dodge leaves in place all wooden blocking used in loading a steel-roofed car so that this material will be ready for use by the dealer when the car is unloaded.

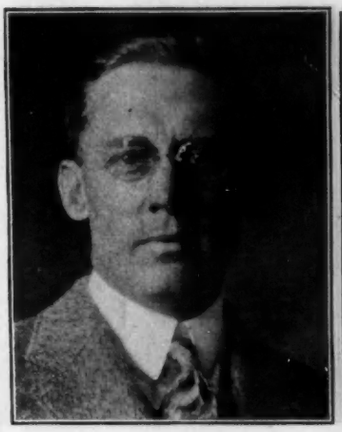
BALLOON TIRES RAISE A LOADING PROBLEM

A new disadvantage of balloon tires cropped up at the Shipping Session. The low-pressure tires lack the rigidity as a mounting that has been available with high-pressure tires and much greater strains are thrown on the wheel blocking when the railroad car is shunted about in the yards. Judging by the general discussion at the meeting, the only satisfactory remedy found to date is to inflate the low-pressure tire to the pressures ordinarily used for high-pressure tires, say 55 lb. per sq. in. E. S. Evans, a specialist in car loading, said that while a hold-down strap having a tensile-strength of 4000 lb. has been satisfactory for use with high-pressure tires, this strength has had to be increased 50 per cent when balloon tires are used. He does not believe that a broad-faced tire requires a grooved wheel-block; a flat-faced block will do. Grooved blocks with shallow grooves, say ½ to 1 in. deep, work very satisfactorily with balloon tires that are over-inflated. Shallow-grooved blocks and flat-faced



EMULATING THE SARDINE

Three Dodge Cars Loaded in One End of an Automobile Box-Car. All Wheels Are Removed and Attached Securely to the Sides of the Box-Car. The Automobiles Are Supported on Their Axle Ends



E. S. EVANS

C. R. SCHARFF

blocks have the disadvantage of being heavier than those having deep grooves. Cars cannot be shipped on the bare rims because the tires are needed as a means of absorbing the shocks met in transit. When a box-car is stopped suddenly in switching operations, an automobile may exert forces on the wheel blocks or loading bucks equivalent to four to six times its own weight.

Several men present objected to the use of deep-grooved blocks with balloon tires inasmuch as these invariably lead to chafing of the side-wall of the tire. Mr. Moore said that great care must be taken to fit the groove to the tire tread and not let any part of the block come into contact with the side-wall. One manufacturer of wheel blocks said that most companies use blocks having 1½ or 2-in. grooves for balloon-tire shipments. Only one or two objections were made against the practice of over-inflation and these were not specific. Dealers must be warned to deflate the tires to the proper pressure as soon as the car is unloaded.

One clever kink was suggested by V. P. Rumely, who presided at the meeting. He recommended that box-cars which have been used for lime or cement shipments be washed inside with a water hose before use. The water sets the lime or cement and prevents its sifting about and lodging on the painted surface of the automobile. Such a scheme saves the expense of lining the box-car with paper. An ingenious scheme for unloading cars without complicated or costly devices was described by C. R. Scharff of the Chevrolet Motor Car Co. Two pieces of lumber of 2 x 6-in. section, and about the height of the freight-car, are placed almost vertically against the side of the box-car and at the line of the front or rear axles of the automobile. Two holes are drilled in each of these boards, one near the top and one near the bottom. A rope is threaded through the holes and the upper end is attached to the axle of the automobile. The free end of the rope, which passes through the lower hole, is grasped by the man doing the unloading and he is able to lower the automobile by letting the rope slip slowly through the holes, depending upon the snubbing action to control the downward movement.

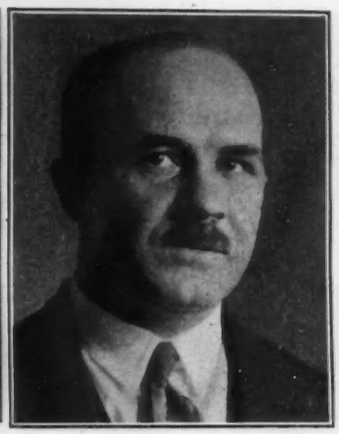
MAKING PLATE GLASS FOR AUTOMOBILES

Possibilities and Limitations Defined by Pittsburgh and Ford Engineers

In opening the Automobile-Glass Session, Chairman George L. McCain referred to automobile glass as a "mysterious" material of which we see much and know little. The inspectors in the automotive plants lack adequate information on the subject; until a few years ago the glass was accepted in pretty much the condition in which it was delivered and utilized in the best possible way under the circumstances.

J. H. Fox, the veteran executive engineer of the Pitts-

JOHN H. FOX



G. L. MCCAIN

burgh Plate Glass Co., gave the members the benefit of his long experience. His paper, which is included elsewhere in this issue of THE JOURNAL, was entitled The Manufacture of Plate Glass for Automobile Uses. He explained that the word "metal" is applied to glass for convenience's sake, to designate the material; and that the two surfaces of the material are called "finish." The first glass made was poured from pots onto stones. Then the blowing of viscous "metal" on the ends of rods and next splitting and rolling it came into vogue. Hand-pouring has given way to machine methods. A tool known as a "bait" is lowered by machinery until its rim is immersed in the surface of the glass, and then raised slowly, the viscous metal adhering to the rim and forming a cylinder that is expanded by compressed air to the desired diameter. The various steps taken in manufacture were set forth in considerable detail by Mr. Fox, covering the drawing, the fire finish, pouring, cooling, annealing and grinding.

The melting pots used in glass manufacture are expensive and take a long time to make. Their life is short because they have to withstand temperatures as high as 2660 deg. fahr. and the chemical reactions of fluxes. The material for making the pots is aged for 2 years. The largest pots hold 2 tons of glass.

The raw materials for making polished plate-glass, known as the batch materials, include silica sand, soda ash, salt cake, limestone, charcoal and arsenious oxide. After 24-hr. cycle in the furnace, the metal is poured onto water-cooled cast-iron tables and then rolled, the resulting thickness of the material depending upon the thickness of two bars of steel known as "trams."

In grinding the glass, sand and various grades of emery are used. The mechanical polishers are treated with "rouge," red oxide of iron. Twice as much power is required for polishing as for grinding.

The continuous method is the last development in plate-glass manufacture. The processes are continuous for making the rough plate and for grinding and polishing it into the finished product. The mixed batch-materials are fed at regular intervals into the melting end of a continuous tank-furnace. The largest of these tank-furnaces used by the Pittsburgh Plate Glass Co. is 32 ft. wide and 140 ft. long. The temperature conditions in the tank furnace are practically constant.

Mr. Fox enumerated the imperfections that are encountered in glass, these being of two general classifications, those in the metal and those in the surface. He emphasized the importance of securing glass that can be seen through clearly without a distorted image. Lack of homogeneity of the glass, known as "ream," is the only defect in polished plate-glass that can cause distortion.

Mr. Fox warned against making specifications for automobile glass too severe; these should not be so restrictive as specifications for glass to be made into mirrors. It is practically impossible to make all the product of the same quality. Leeway must be allowed in the thickness of the finished plate. It is very costly to grind to a definite thickness.

With regard to the strength of the glass, the tempering is the important thing; the glass becomes rotten if cooled too slowly and brittle if cooled too quickly. The temper should be the same on both sides and uniform over the areas. The cost of regrinding and repolishing to eliminate scratches is almost prohibitive.

By way of generalizations, Mr. Fox said that nothing equal to hand-made pots have been found for making plate glass, and that the production of a glass plant is very small compared to its size and cost. He showed a very interesting lot of samples of glass containing the various defects he had listed.

C. W. Avery, of the Ford Motor Co., related different aspects of the experience of that company in making plate glass. Being new in this field, various expedients that men of long experience would have shunned were tried. The Ford Company uses the continuous method of manufacture. Mr. Avery said that greater care must be taken in maintaining this process than in using the pot and circular-table method. The Ford tank holds 500 tons of molten metal. It takes weeks to eliminate contamination in the metal. The greatest troubles are due to variations in the metal. The sand must have low impurity-content and high silica-content, the latter not varying more than 1 or 2 per cent.

Mr. Avery said that a continuous-process plant of a given output in sizes of sheet produced by his company can be built for one-half what a pot and circular-table plant would cost. The first saving is in eliminating the pots themselves. An additional large saving is effected in the cost of rolling, the rolling machine being operated at all times by one man, between furnace and lehr, as compared with from four to six men with the pot method.

The Ford Company does not roll plate glass wider than 40 in. By use of the continuous process it has reduced the cost of glass 30 per cent. Mr. Avery said that no unusually large profits are being made by anybody in glass manufacture. The day of 20-cent glass passed when automobile glass ceased to be a by-product. Originally, the automobile industry was an outlet for small sizes of glass. Today, that industry consumes more glass than does any other industry.

In the pot method of manufacture the thickness of the glass depends on the necessity for pushing large sheets into the furnace; to prevent buckling, a certain resistance must be provided. The Ford Company can roll continuously glass 5/16 in. thick. By strenuous effort it has been reducing the thickness 0.020 in. at a time.

In reply to questions, Mr. Fox said that the rolls are made of cast iron; that the purpose of using arsenic and soda in the batch is to refine and decolorize the latter; that the best way of testing glass is to see how it cuts.

He said that the securing of freedom from bubbles is the nightmare of glass manufacture. This is the reason for holding the batch materials for a long time at a temperature of over 2600 deg. fahr. Devitrified glass is glass that has become partly crystallized; it becomes opaque. Ordinarily, glass should not change materially after being stored, if the batch materials have been good. Glass that has been allowed to "soak" long enough should be free from strains due to rolling. What the automobile industry needs is essentially a tough glass. With regard to specifications, major defects such as "stones" should be prohibited but it is difficult to cover minor defects such as "seed." As to a standard for variation in thickness, the Government standard for glazing glass was the only one of which Mr. Fox knew. He thought that for ¼-in. thick glass a tolerance of 1/32 in. plus and minus might be feasible.

As to laminated glass, with a layer of non-glass material between the glass plates, Mr. Fox cited as objections discoloration of the non-glass layer, expense and liability of increased distortion of vision.

As to the total loss of material in glass manufacture, Mr. Fox said that this varies from 10 to 20 per cent in the pot method. In the case of the continuous method, Mr. Avery said that this loss is from 8 to 9 per cent.

WASTE REDUCTION IN INDUSTRY

Economies Effected by Careful Research and Rigid Control of Shop Practices

Conservation of raw materials by waste-reduction methods has certainly not been outstanding in American industry. In comparison with conditions abroad, our domestic situation shows to very poor advantage and offers possibilities for vast improvement. Whether this state of affairs is brought about by differences in economic conditions or through other potent forces is more or less beside the point. The undeniable facts should be of sufficient significance to arouse more widespread interest in measures based upon sound fundamental research calculated to effect economies.

It is of great interest to note that many of our industrial organizations, both large and small, are attaching greater importance to the study of possible savings. Among the larger organizations that have concentrated upon this problem the Westinghouse Electric & Mfg. Co. offers a very interesting example. In the plants of this company no item is too small to justify careful study with a view to saving.

At the Waste-Reduction Session, members and guests of the Society were privileged to listen to a very interesting paper on Westinghouse methods presented by Carl B. Auel who has charge of waste prevention and utilization in the company above mentioned. The paper appears on p. 407 of this issue of THE JOURNAL and is worthy of careful study.

In the discussion of Mr. Auel's paper, attention was directed by the speaker to the fact that a typical workman on a given job would receive 66 cents in Germany, 67 cents in France or Belgium, $1 in England and $1.98 in America. These facts were cited to show how the Continental manufacturer has a real advantage over the American manufacturer on the basis of wages.

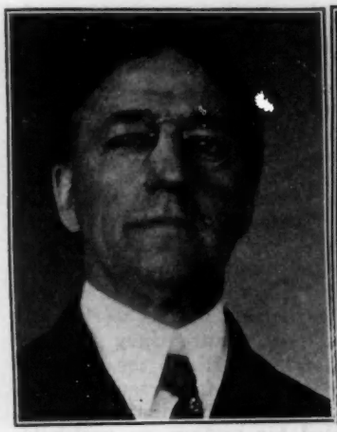
In connection with purchase specifications Mr. Auel warned against too rigid adherence to set requirements. Examples were cited in which this practice without the exercise of proper discretion would react to the disadvantage of the purchaser.

Certain materials were said to be purchased on a basis of comparisons with standard specimens kept for this purpose. Marble, for instance, must have the proper insulating qualities and must also compare favorably as regards appearance with a standard sample.

Henry W. Abbott, General Motors Corporation, spoke of two large automobile plants with approximately equal production which compared on a ratio of 5 to 1 in wastage of sheet steel. Investigation showed that the more favorable conditions resulted from cooperation between the shop men and the engineering department.

Chairman Herrmann elaborated on this point and recommended the practice of preparing drawings in such a way that the shop man can use some discretion in his choice of material. In certain cases it would be possible, for example, to indicate that 12, 13 or 14-gage sheet-steel could be used. Much material that would otherwise be scrapped can thus find its way into profitable use.

John Younger mentioned the fact that many shop men prefer recut files for work in brass.



C. B. AUEL

L. A. CHURGAY

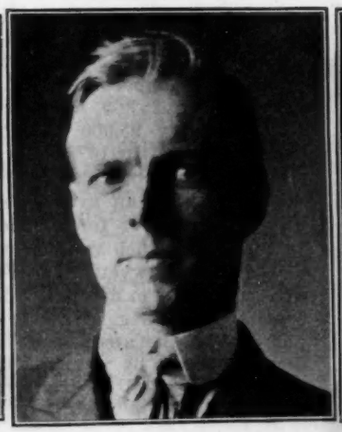
CHURGAY ON TOOL SALVAGING

In line with the general subject of waste prevention is the question of tool salvaging. Methods employed in this work at the plant of the Maxwell Motor Corporation were outlined interestingly by L. A. Churgay of that corporation. His paper is printed in full on p. 456 of this issue of THE JOURNAL.

The discussion brought out the fact that drills of, say, ¾-in. diameter when badly dulled and worn can be ground down to a diameter 1/32 in. under size. Further reduction than this is not practical according to Mr. Churgay. Many uses are found for tools slightly under size; the toolroom can ordinarily use large numbers of them, and maintenance work employs many others. A further possibility is selling them profitably to salvage men.

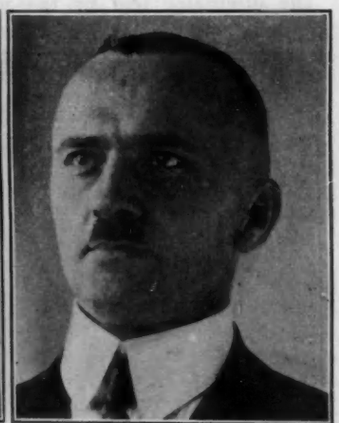
In cases where a drill is used over a reasonably small portion of its length, in jig work for example, it is possible to extend its period of service after the used portion becomes badly worn, by lengthening the shank and thus bringing a new section into action. Many used drills are ground to form counterbores. After all possible cutting value has been derived from the tool, it can finally be sold to a salvage man, after the carbon shank has been separated from the high-speed steel. Companies dealing in high-speed steel offer ap-

K. L. Herrmann
Studebaker



Earle Buckingham
Pratt & Whitney

Dr. Georg Schlesinger
Germany



G. A. Schreiber
G. M. C. Truck

ACTIVE PARTICIPANTS IN THE DISCUSSION

proximately 20 cents per lb. for the steel in exchange for new stock.

Mr. Churgay believed that the attitude of shop foremen is generally favorable toward salvaged tools. Certain others reported that their experience had been to the contrary and that it is often difficult to convince men of the advisability of using such stock. Several possible methods of overcoming this difficulty were mentioned.

In a certain shop it is the practice to issue salvaged tools without charging them against the department that uses them. A foreman who takes pride in keeping his tool charges low can often effect considerable savings by taking full advantage of the salvage stores. Another shop allows each foreman a certain amount of tool value for his work. Any reduction that he is able to make in the necessary allotment presents a favorable evidence of his worth to the company. Keen competition among the foremen often results in expenditures of only 60 or 70 per cent of the allotted amount. Bonuses are sometimes awarded for savings on perishable tools.

Mr. Churgay stated that tool allotments in his plant are based upon statistics applying to past performances. One objection to this practice is the possibility of following a faulty allowance. It was suggested that a more sound policy would be to investigate each type of tool thoroughly to determine its capabilities for a particular job and then to base the allowance on data thus obtained.

Buffing wheels that have been greatly reduced in diameter were reported to be salvaged by one firm by separating the parts of the buff and then punching the spindle-hole off-center by a sufficient distance to bring the reassembled wheel to the proper diameter.

In connection with the bad practice of using tools after they have become dulled, it was recommended that inspectors be assigned the task of detecting such faults and remedying them.

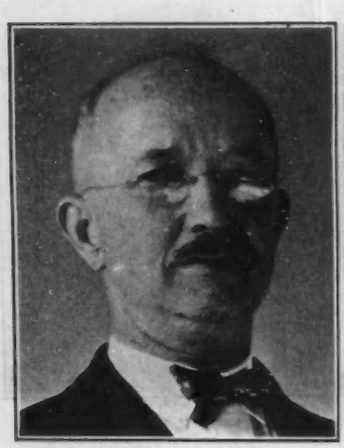
It was suggested that a future meeting of the Society be devoted to the consideration of possibilities for selling waste materials at profitable prices.

The Waste-Reduction Session above reported was under the chairmanship of K. L. Herrmann, Studebaker Corporation of America.

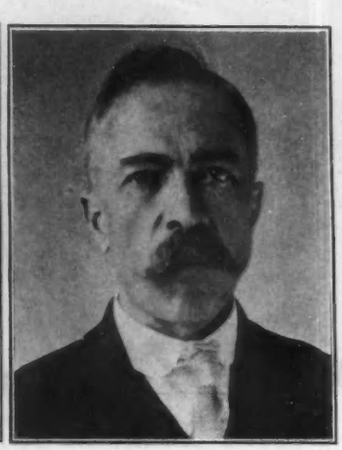
WOOD FOR AUTOMOBILE BODIES

Its Structure, Properties, Deformation, Seasoning, Storage and Preparation

Lumber, its seasoning, storage and preparation for use in automobile bodies, was the topic of one of the most active sessions of Production Meeting. Although somewhat lacking in size, the session more than made up for this oversight by the keenness of the interest of those who participated in the discussion and by the number of questions asked per person in attendance. Taking advantage of the fact that those who furnished the subject matter of the gathering were thoroughly competent to clarify many points regarding the action of wood in drying that have not previously been thoroughly understood by the automotive engineer, the eager listeners kept the speakers busy answering questions until a late hour.



B. Nagelvoort



H. D. Tiemann

In opening the meeting, Chairman George J. Mercer called attention to the problems connected with the use of lumber, its lack of quality and the expense of the kinds that are produced. The Society's Committee on Hardwood Lumber Standardization, working in conjunction with the Forest Products Laboratory, has done a great amount of research, he said, but has not yet reached tangible results.

In his paper on Lumber Problems Encountered in an Automobile Plant, the first speaker, B. Nagelvoort, of the Towson Body Co., described yard layouts and equipment for the efficient handling, storing, drying and cutting of lumber, emphasized the importance of obtaining reliable data and submitted many tables covering types and sizes of trucks, the capacities of kiln-cars, the sizes and gages of transfer cars, kiln performance, shrinkage tests, methods of loading kiln-cars, crosswise and endwise, and also curves showing the moisture content after varying periods of drying and views of the manner of nesting patterns in cutting lumber that is in use in the Ford plant.

One-third of the tree, the limbs and the top, Mr. Nagelvoort said, is wasted before the log gets to the mill; only from 55 to 60 per cent of the log is actually converted into body parts. Most manufacturing plants have very little control over the lumber before it enters the railroad siding, but the Ford Company begins at the selecting and the cutting of the tree. If the lumber were furnished to the stock sawyer in the lengths and widths most suitable for the nesting of patterns, as is done, for instance, with sheet aluminum and upholstering materials, the waste could be reduced to the maximum of from 10 to 15 per cent.

Saving of Lumber by Nesting Patterns

A board 5 in. wide will cut one body pillar, a board 8 in. wide will cut two pillars; by properly nesting the patterns, each additional 3 in. of width will cut another pillar. The expense of lumber and the cost of labor, he said, had become so great that economy in handling is necessary, hence, the need of rapid turnover of lumber stocks, with the minimum of labor requirements. This is met by dry-kiln storage on wheels. Tests of the dry-kilns show that the lumber gives up very little moisture until the humidity has dropped below 80 per cent, indicating that the time consumed prior to that point is wasted. An apparatus controlling the temperaure and the relative humidity over a predetermined time has recently been placed on the market. This instrument operates by cams and diaphragm valves actuated by wet and dry-bulb thermometers and entirely eliminates the human element. Improvements in future dry-kilns, Mr. Nagelvoort said, will probably be centered on better insulation from outside atmospheric conditions, better control of temperature and better temperature distribution. In cutting wood parts for a run of 300 five-passenger closed bodies, requiring approximately 95,000 ft., board measure, of stock ranging from 4 x 4 to 4 x 16 in., by using waste from the thicker stock for small parts or for ripping up for use in the Lindermann machine, an average saving of about 50 per cent has been effected over former methods in vogue in body-building factories, in which random widths and lengths were supplied to the stock sawyer. The Ford method of nesting patterns and sawing them directly from unedged green planks as they come from the log is said to effect a saving of from 35 to 50 per cent in the amount of lumber required, to simplify the drying process by reducing the spoilage due to warping and end-checking and to shorten the drying time by approximately 10 days.

Secretary Hoover's Conservation Policy

Referring to Secretary Hoover's conservation policy with regard to the forests of the Country, C. A. French called

E. N. Sawyer, Rollin — G. A. Holmes, Dodge — L. K. Pettibone, Willard Battery — L. J. Friedlander, Maxwell

FOUR EXECUTIVES WHO ATTENDED

attention to the importance of saving wood, stating that a saving of 10 per cent of the waste in automobile-body plants would amount to as much in 10 years as could be reproduced in the fields in 100 years. A few years ago, he said, no trouble was experienced in getting hard, sound white ash from the North; now we must go to Arkansas, Louisiana and Mississippi. The wood from this section usually includes some soft ash.

Chairman Mercer, reviewing the work of Secretary Hoover's committee, said that so far the stock-cutting lists of from 30 to 40 factories had been studied and the parts classified. Sizes of the same piece vary in different factories. The committee has tried to bring about dimension-cutting at the mill, with the idea that what would be considered as waste in the automobile industry might be used for making furniture or similar articles in other industries.

The subject of the use of the Lindermann machine brought out varied opinions as to its practicability. Chairman Mercer stated that his shop could not afford to use it, that the waste in using it is large, that it takes four men to operate it and that, on account of the large investment involved, it is usually cheaper to buy lumber than to try to conserve it by utilizing the Lindermann machine. Mr. Nagelvoort replied that in gluing dashes for trucks by hand the waste is considerable. A Lindermann machine in his plant, he said, had paid for itself four times in a year. He considered it a great time-saver. Further discussions of the subject showed a division of opinion as to the merits of the machine. Waterproof glue was said to have the disadvantage of containing lime, which makes it hard on the cutting knives.

WOOD FROM THE HACKBERRY TREE

A peculiar wood that is usually considered to be of little value comes from the hackberry tree, which grows in the South, said L. L. Williams. One firm uses it exclusively for floor-boards. The tree is about 48 in. in diameter at the butt and grows about 20 ft. high. In texture and grain it appears like ash, but it has not the strength or value of ash. It is used by one particular company wherever they require four-quarter stock. The wood is inexpensive and very clear, has a negligible amount of waste, comes in nearly all widths and does not change its shape. The same company uses the odds and ends of waste lumber to make step-ladders, clothes-pins and inexpensive ice-boxes. It buys only log stock, which is double surfaced, jointed and ripped, every piece going through a sticker and being sized.

H. D. Tiemann, of the Forest Products Laboratory, in his paper on the Causes of Surface Checks in Wood in Varnish-Drying Rooms, devoted his attention to a description of the complex cellular structure of wood and the deformation that accompanies changes in the moisture-content. The paper is printed in full on p. 431 of this issue of THE JOURNAL.

In the discussion, Mr. Tiemann replied to an inquiry regarding the effectiveness of a preliminary coating of oil in preventing checking by saying that neither linseed oil nor spar varnish will retard the absorption of moisture. It will retard the actual taking in of water that is splashed on, that is, the water will not soak in so quickly. But the wood will absorb moisture from the atmosphere almost as quickly as will normal wood. Some fillings, however, will prevent the absorption of moisture.

CONTROL OF TEMPERATURE

The control of temperature, continued Mr. Tiemann, is rather impracticable, but is highly desirable in wood shops, especially where such delicate parts as airplane propellers are made. It is essential that the humidity should be controlled. In automobile-body shops approximate control is desirable. In the winter when the steam is on, the air is excessively dry. In summer, when the temperature is 80 or 90 deg. fahr., a nearly saturated condition exists. If it could be arranged, a temperature from 5 to 10 deg. fahr. hotter than the outside air would be desirable in the summer, and a slight amount of humidity should be added in the winter. Neither amyl acetate nor turpentine will have an appreciable effect on absorption. Special studies of the protective effects of different coatings and varnishes, he said, had been made at the laboratory, but most of them are not protective.

Obtaining a cue from one of the Forest Products Laboratory's reports, A. I. Stevens, of the Oxford Varnish Co., said that his company had developed a coating for retarding the absorption of moisture during the baking process so that the moisture-content during this period remains constant. This process has been in successful use in one of the large production companies for 3 years. Learning also that the constancy rather than the amount of the moisture-content is essential, the same process maintains the moisture-content at about 3½ per cent during baking and prevents additional moisture from entering the wood. The chief difficulty is in getting a uniform coating over the body and in sealing the ends of each piece. In applying the process it is desirable to get the wood before it has been assembled or the frame before it has been paneled.

Entire prevention of the absorption or the loss of moisture, said Mr. Tiemann, is not necessary. Mere retardation will accomplish much good. Sudden changes produce excessive stresses. Experiments that he has made confirm the last statement, said Mr. Stevens. The process contemplated from 4½ to 5 hr. of treatment before the paneling is attached to the body.

Replying to a query by A. E. Corbin, of A. S. Nichols & Co., Mr. Tiemann said the statement regarding the non-prevention of absorption by linseed oil was true whether the coating is moist or dry.

Importance of Relative Humidity

Mr. Corbin added that his experience with the drying of paints showed that the relative humidity of the drying-rooms is very important, as several automobile companies had found out to their cost. When the temperature and humidity are properly balanced a painted surface will dry in one-eighth the time otherwise consumed. When production is rushed and the painting process is hurried it is better to begin with the rough coats and neglect the finishing coat than to apply the finishing coat without the supplementary coats.

When he had attempted to maintain the conditions outlined by Mr. Tiemann, the paint spalled. There must be a happy medium, said Mr. Nagelvoort, because the paint cannot be entirely neglected in favor of the wood.

To a question regarding the use of a first coat better than boiled linseed oil, Mr. Tiemann replied that, although linseed oil is standard throughout the paint trade, its value is greatly exaggerated. It is not a preservative in the sense of being an antiseptic in fungus attack. It retards only slightly the alternation of moisture and consequently reduces the tendency toward compression checks. It keeps out dirt and prevents splashings of water from injuring the wood.

A preservative that penetrates too much defeats its own purpose, said Mr. Stevens. A kitchen floor may be covered with successive coats of linseed oil until it acquires a luster not removable with a scrubbing brush, but for automobile work linseed oil is a failure.

Stability of Materials in Wood

To Mr. Williams' question regarding the moisture, acids and residue left in improperly dried lumber, and the penetration of a preservative, Mr. Tiemann replied:

> Presumably no change takes place in the chemical materials in the wood, due to the removal of the moisture. There are very few acids in most wood. Certain species contain some acid, chestnut, for example, and there is a certain amount in oak, but it has nothing whatsoever to do with the ability of the wood to take on or to lose moisture to the air. No ordinary treatment changes the property that we call hygroscopicity. The wood will continue to absorb moisture and to lose moisture indefinitely with the changing of the humidity of the air. There has been a very popular idea as to the efficacy of steaming lumber, for instance, to remove the so-called proteids, acids, and other things in the lumber. As a matter of fact, that does not occur. There is a possibility that some of the starches may be hydrogenized into sugar and rendered soluble, but the effect on the lumber is practically nil; it cannot be traced. The popular term, sap, that is, getting the sap out of the lumber in order to make the lumber more permanent so that it will hold its shape better, is an altogether fictitious idea. There is no removal whatsoever of any of the chemical products of a piece of white oak, for example. Those products are sealed up inside the wood just as effectively as if they were in a tin can. No change takes place in them. The moisture passes off and they are still there. It is possible to leach out, by soaking, the so-called sap, which contains hydrocarbons, chiefly sugars; but this leaching out does not produce the relatively high results expected. Sugar seems to affect the shrinkage of the wood slightly. Wood covered with glycerine will not shrink at all because the glycerine is hydroscopic and will keep the wood moist. I think you can generalize to the extent of saying that nothing takes place in the ordinary drying of a piece of lumber that affects directly its ability to absorb moisture or to lose it. If lumber is heated to 300 or 400 deg. fahr. for about 4 hr. its properties will be changed chemically. Its hygroscopicity is reduced very appreciably. There are two solutions of the problem of avoiding trouble in the varnish-dry room. One is to apply a coating that will retard the transfer of moisture. The other is to regulate the humidity of the shop. Too little attention has been paid to that phase of the subject.

BONUS PLAN IN PAIGE TOOLROOM

Its Operation the Topic of Greatest Interest in the Tool Design Session

Eclipsing detail points of tool design in general interest, the payment of bonuses to tool-makers in the Paige plant developed into the major topic of discussion in the Tool Design Session of the Production Meeting. Up to the present time it has been considered impractical to apply any form of wage-incentive plan to such precise work as the making of jigs and fixtures. But Joseph Lannen, tool and equipment engineer of the Paige-Detroit Motor Car Co., disclosed the fact that this organization has had such a plan in successful operation for many months and the efficiency of the tool-makers has been increased appreciably as a result.

Disclosure of the Paige toolroom bonus policy was really an incidental part of Mr. Lannen's valuable paper that dealt primarily with the economic aspect of tool, jig and fixture selection for interchangeable production. The speaker emphasized how necessary it is to keep in mind at all times the *ultimate* quantity of parts to be produced from the particular group of machines, jigs and fixtures being selected. He showed slides that presented graphically the relative productive efficiencies of three different arrangements of machines which might be selected to perform the drilling operation on a crankshaft bearing cap. Using these graphs, and keeping in mind the ultimate quantity of the piece to be produced, it is possible to put one's finger on the single method that will produce this quantity of caps at the minimum over-all cost. Such methodical procedure avoids the purchase of expensive machine-tools having great productive capacity unless the ultimate quantity to be produced justifies the investment.

Mr. Lannen said that tool designers can effect savings in the cost of tooling by avoiding difficult machining operations and unnecessarily close tolerances in the construction of jigs and fixtures. Core work on patterns should be avoided wherever possible. If proper attention is given to pattern simplicity in the tool design room, pattern costs can be reduced.

How the Paige Toolroom Bonus Works

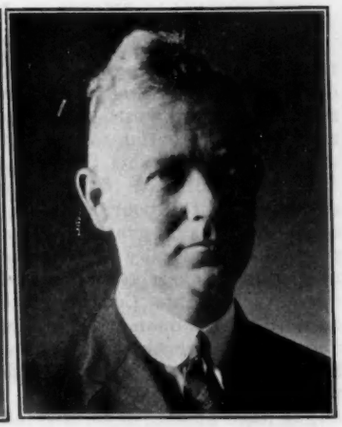
The cost of all work assigned to the Paige toolroom is estimated carefully and the number of estimated man-hours for each job is forwarded to the time department. At the end of each pay period, the estimated time on the jobs completed is totalled and from this is subtracted the actual time turned in by the workmen. Fifty per cent of the difference, where the estimated time exceeds the actual time, is distributed pro-rata among the tool-makers based on their respective earnings for the pay period. Very little additional clerical work is required, team-work is promoted among the tool-makers and there is assurance that the tools built will average lower than the predetermined cost.

The bonus plan is only under trial at present, but the tool-makers have been earning a bonus regularly. This shows that the men are working close to the estimates whereas they used to exceed them as much as 75 per cent before the bonus plan was installed. Mr. Lannen said that the estimators are able to judge costs accurately, usually being within from 5 to 10 per cent of the actual figures. They are able to base their estimates in most cases on fixtures of similar design, the cost of which is a matter of record. When an estimate is low, the tool-maker is penalized, but such penalties will be offset by other jobs on which the estimate is high, so that he is treated fairly in the long run. It must be remembered that all tool-makers are guaranteed a standard day-rate. The bonus merely offers an incentive for them to work at top efficiency.

Estimates Made From Sketches Of Tools

Preliminary sketches are made of every tool by the more expert tool designers and it is from these sketches that all estimates are made. The tool draftsmen who make the

EUGENE BOUTON



JOSEPH LANNEN

finished drawings find sufficient information on these sketches to enable them to complete the drawing of the jig or the fixture without any other assistance. Mr. Lannen said that he prefers young men in the tool drafting department since they work faster than the older men who have been in the trade a long time. About 30 draftsmen are employed in the Paige tool design room. One estimator is able to handle all work that is done in the tool shop which employs about 30 tool-makers. All tool work is not done in the company's own shop.

Commenting on Mr. Lannen's paper, A. L. De Leeuw said that estimates of tool, jig and fixture costs can be made accurately by referring to similar tools made in the past, the costs of which are known. He recommended a system of standardization of jig and fixture parts wherein all levers, bushings, clamps, feet and similar pieces that can be used over and over are listed in a standard group. No new pieces of this classification can be designed or added to the standard list without the approval of the executive in charge of tool design. In one instance where this system was used, the original list was increased only 2 to 3 per cent in a period of 5 years.

MISTAKES TO AVOID WHEN DESIGNING TOOLS

Mistakes that should be avoided in jig and fixture design were set forth in an interesting paper by Paul V. Miller that is printed in full starting on page 445. The paper was read by V. B. Lyman. In the general discussion following the paper, James N. Heald said that insufficient attention had been given by tool designers to chucks or fixtures for holding pieces during grinding operations. Too often the expenditure of thought and money on tools was unevenly distributed; for example, the automatic screw-machine department will be equipped with excellent tools, while the grinding department has to depend upon a simple three-jaw chuck to hold and center gears when grinding the piloting flange. This raised a point regarding the proper place to use as a locating point for this operation. Opinion was divided between the pitch-line method and the root-diameter method.

R. R. Keith said that clamping of work in the fixtures was often overdone. He favored placing locating points on the side and the ceiling of fixtures in order to make the fixture self-cleaning. Locating points should not be adjustable, or if adjustable the adjustment must be sealed. Eugene Bouton, who was chairman of the session, said that screw and nut clamps should be replaced by cam-lever clamps wherever possible to reduce the time taken by the operator in loading and unloading a jig. A. L. DeLeeuw believed that too much money is spent on jigs and fixtures because the designer does not keep in mind that these devices should only be good enough to produce the accuracy demanded in the particular piece for which they are intended. Mr. Lyman judged that from 20 to 25 per cent of the total cost of the average jig or fixture was chargeable to the designing and drafting work.

PRODUCTION DINNER REPRESENTATIVE

Problems of the Industry and the Nation Discussed

The Production Dinner, held at the Hotel Statler, was probably the most representative event of the kind ever held, from the standpoint of the number of leading automotive production-men present.

President Crane was eminently satisfactory in what he said was his first effort at toastmastering.

Herbert H. Rice, president of the Cadillac Motor Car Co., in connection with the matter of what men have rendered conspicuously distinguished contributions to the automotive art and industry, said that he could not name offhand many individuals to whom the steps in the progress of the industry could be solely attributed. That, he felt, was a matter of much credit to the industry, indicating great cooperative effort. No man and hardly any group of men can claim the exclusive credit for any specific development.

The subject of Mr. Rice's address was

WHAT SHOULD BE THE ATTITUDE OF THE ENGINEER TOWARD THINGS NEW?

He asked whether the sentiment expressed by Pope: "Be not the first by whom the new is tried, nor yet the last to lay the old aside," should apply to the automotive engineer of today. He said:

> Certainly, in the early days of the industry there was no tendency toward conservatism in the adoption of new things. Many engineers seemed to work on the theory that it was better to discard a design entirely and try something new than to perfect the first design, Mr. Ford excepted! Of late years, however, there has, I think, been a tendency to keep in the rut and to follow the path which has already been blazed. It is true, of course, that there is not the opportunity for novelty in design; things have settled down through the law of the survival of the fittest.
>
> But there is a marked difference between American design and design abroad. If the Paris automobile show just concluded was like previous ones, you could walk from booth to booth and find chassis of different treatment one from the other. You could see novelties that had never been shown before and likely, it is true, never to be shown again.
>
> This may be accounted for in part by the fact that many of the heads of the foreign automobile companies came up from the engineering side of the business. As a friend of mine said to me, "They have a pride of individual design and they follow it to the utmost; of course, they don't make any money, but they have an awfully good time."
>
> Still, they have shown us the way in many things. The four-wheel-brake development was more than a year ahead of us and was universal on the Continent 2 years ago. We have followed them in high-speed engine design, and in the early days followed them in transmission design. Today they are bringing out what are considered by some to be freak designs in transmissions, spring-suspensions and other things.
>
> Of course, we should not change merely for the sake of changing. Let us leave that to the body designers, the style group of our business. But is there not something to be said just now in favor of a more receptive attitude toward new things? In Spenser's Faerie Queen, Faire Britomart saw written over the door, "Be bold," and in the next room she found over the door, "Be bold, Be bold" and everywhere "Be bold." Only finally at the upper end of the room, was still another door whereon was written "Be not too bold."
>
> For the engineer, then, let the advice "Be bold." Leave the admonition, "Be not too bold," to the cautious general manager, who will, I am sure, supply all the caution that is necessary.
>
> The engineer must, I think, be more forward-looking than ever before, and for very good reasons. The

saturation-point has been thus far only another name for the vanishing-point. The wolf has been at the door more than once. We have heard him howl. But when we listened at the key-hole, we discovered that it was not the wolf but only the calamity howler; and, like as not, instead of being outside, he was in our very midst. When the wolf really does howl at the door of the automobile industry, it will be up to us to slay him. And the engineer will have his particular part in that performance. Production has pushed the saturation-point further and further away. If the marvelous decrease in the cost of production had not taken place in this industry, we would have been within sight of the saturation-point years ago. It cannot be expected that lessened cost of production can make in the future anything like the progress it has made in the past. From now on it will be at best a slow process. But you can make everyone in the Country desire to do away with his old car and get a new one.

Mr. Kettering likes to tell the story of how the cash register had reached a point of saturation in the saloon business. The Dayton engineers approached this sales problem from an engineering standpoint and developed a new register which was so greatly superior to those in use in saloons before as to make every one of them obsolete. A whole new era for cash-register business in saloons was opened up. This is the sort of thing we must do, and what I am sure we are going to, in the automobile industry.

Of course, that has been done already in large measure. Suppose we had left our body designs as they were 5 years ago. Our trade-ins would have been half of what they are at present, perhaps less; for we know that the good chassis built 5, and in many cases 10, years ago are still giving reliable service.

The reduction in cost of good closed-bodies has in a measure obsoleted the open-car body. It may be that, except in the case of the cheaper cars, the open car will be a sign of the well-to-do man who can afford two cars. We must be forward-looking. It is to you that we look for the changes which will push away still further that saturation-point, of which I personally have no fear whatever, because I have faith in the automobile engineers. Mr. Kettering has said that the next 5 years will show more new things in the automobile industry than have been developed in the last 10 years.

What the changes shall be, I do not know. If I could tell in advance I would be wise indeed. But that they are coming, I have absolute faith. "Let well enough alone" is a cowardly policy permitted only to the general managers.

Waste in Industry

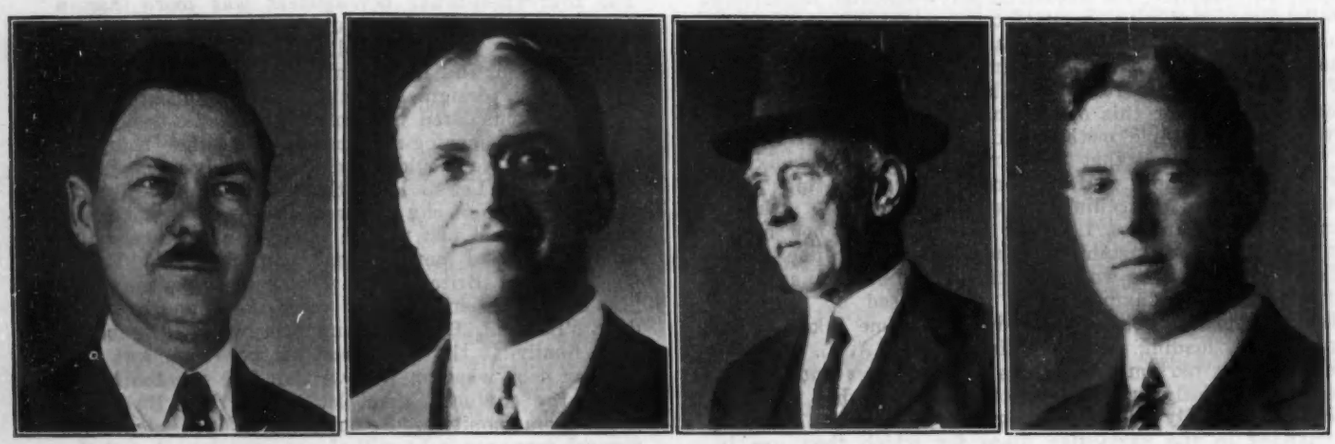
Carl B. Auel, manager of the employes' service department of the Westinghouse Electric & Mfg. Co., and president of the National Safety Council, who had addressed the members at the waste-reduction session on Thursday afternoon, called attention to the fact that in accomplishing many wonderful things this Country has been inordinately wasteful. He said that, if we do not change our methods, we shall transmit a poor heritage, leaving for those who shall come after us a greatly increased cost of living. He expressed emphatically the opinion that the matter of greatest importance is our total lack of standardization. We have currently in this Country 80,000 fatalities and 2,000,000 casualties of human beings. Twice as many as in England, and many more than in Japan. Indirectly, the consequent losses mount into billions of dollars. We cannot conceive what losses we may incur, in view of what one lost life might have amounted to in intellectual or industrial development. Our losses by fire amount to $500,000,000 annually. In the lumber industry, Mr. Auel said, 65 per cent of every tree cut down is absolutely wasted. Furthermore, that the automobile industry is permeated with waste.

With regard to European wages, Mr. Auel expressed the opinion that, to have a fighting chance with our foreign rivals, we must excel them in economies. If in Germany a given piece of work costs 60 cents, it costs in Belgium or France 67 cents, in Great Britain $1, and in this Country $1.98. Lacking adequate economies, we could not under certain conditions compete with the foreign countries, even if our import dues were doubled in amount. Japan has taken our trade in Easter novelties that was formerly held by Germany. The same thing is true of Christmas decorations and of toys. Germany is making "Chinese" copies of our shoe-making machinery. In trade generally, the European countries have the advantage of us in the length of water haulage of freights. Mr. Auel feels very strongly that the rank and file of the American people should be impressed with the facts of the conditions he outlined.

Engineer Leadership of Labor

E. M. Mulock, who gave the concluding address, has had an extraordinarily varied experience which qualifies him extremely well to talk on points of the greatest moment to industry in connection with the relations of employer and employe. He has been a minister of the gospel, a court probationary officer and a business man, as well as having served conspicuously in the sociological department of the Ford Motor Co.

Mr. Mulock said that the cause of the many disappointments in "highly-thought-out" plans for dealing with men has been the feeling that the men could be molded to employers' desires. In dealing with men in masses, we are



D. E. Gamble, Borg & Beck — L. J. Holmes, Nash — John McGeorge, Oakland — R. Z. Hopkins, Hudson

Another Group of Production Men

dealing with the same thing we are ourselves; the men have the same great motives and aspirations. Mr. Mulock feels that we now stand in the brightest day in history, a more glorious day than has ever been before. Over a long road humanity has marched steadily onward and upward.

The speaker said he was not worried about what Japan will do. We shall work out methods of working together. The world will not be less kindly and helpful than it has been.

The human element is the most elastic thing in industry. Ordinarily, Mr. Mulock said, people have an efficiency of 60 per cent. During the war, possibly our general efficiency was between 75 and 80 per cent. An additional 5 per cent of efficiency increases profits. Ten per cent additional efficiency will perhaps meet the Japanese case.

We must get at the mind of the men who work. All kinds of wages and conditions have been offered the men, without their responding. Ford was not the first to have the 8-hr. day. But Ford proceeded differently from others. He said, "We will give you an 8-hr. day and pay you more." This is not like something received that has been petitioned or demanded. The feeling of interest and sincerity makes all the difference. Ford rewarded labor with a larger share of the earnings than had been given before; without conditions in any way. The response was the natural human response. Employment was made secure. There was no discharging of men except for moral offences.

The speaker continued:

> In unemployment, the gap between a job and no job is tremendous. The ignorance of employer and employe of each other and their purposes is amazing. There is a terrorizing fear in the minds of men dependent on someone's will beyond their control for their jobs. Feelings, not reason or logic, govern men. No virtue obviates dislike. Nearly all reasoning is to justify one's own feeling.
>
> Men will invariably take immediate wages rather than prospective profits. This action centers around the feeling that the job must be protected. A man out of work is not only without income; he is lost.

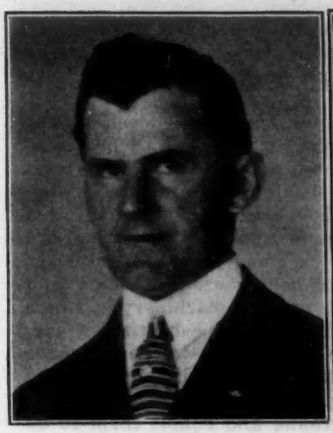
The word Mr. Mulock wished to leave with the members is that there is a marvelous opportunity for leadership for them in industry. Several groups are pleading for leadership. Every man needs to be linked with some cause greater than himself. Every man, however he seems, is a more or less lonely soul who must be linked to something to make him loyal. Every man is more or less restless until he becomes bound to some satisfying service. The men in the shops have the same purposes and desires. They are looking for the right kind of leadership, guided by understanding.

FACTORY MAINTENANCE AND REPAIRS

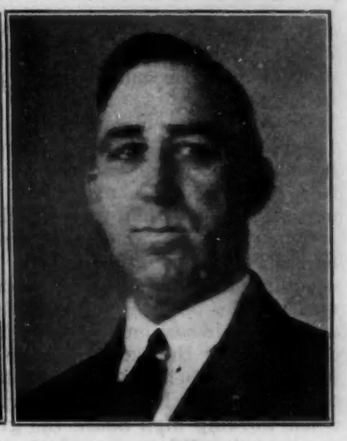
Plant Organization at Olds Works and Some Operating Kinks of the Ford Company

Maintenance, the manufacturer's greatest problem, enters materially into the life of every man, woman and child, said E. E. Remington, in describing the Maintenance Practice at the Ford Plant, of which he is the maintenance superintendent. Great difference of opinion exists, he said, as to the proper way of installing equipment and of maintaining a plant. This can be observed by walking through or merely driving past a plant. Some think that the less money spent in maintenance the more will be made; others believe in spending enough to maintain their plants properly. The latter is the policy of the Ford Company. The real satisfaction of having a plant well painted and everything in good repair and in good working condition for the men is itself a big argument in favor of adequate maintenance. You are then in a position to demand good results and nothing can prevent good results from coming from good conditions.

Why is maintenance the manufacturer's greatest probem? One reason is that it is non-productive; the cost, therefore, should be kept as low as possible. What methods can be applied to give a high rate of efficiency at nominal cost? Building up a live organization, he replied, answering his own question, one that is out to give service and to give it promptly and in an efficient manner; an organization built up of men of all the different trades equipped to handle any job that may arise. In a large plant, very little work, he said, should be contracted for on the outside, for if done inside the plant the work will be better, and it will be done more promptly and at a lower cost.



L. A. Blackburn



E. E. Remington

Standardization of Equipment

Of great importance in lowering the cost of maintenance is the standardization of equipment, such as hangers, bearings, pulleys and the like. This means cooperation between the maintenance and the purchasing departments. Next comes the standardization of the methods used in carrying on maintenance work. When an order is given to set a machine, build a conveyor or install a lineshaft every man should know exactly what material should be requisitioned, and how the work should be done. If followed out carefully, this will give a uniformity of installation that will add materially to the appearance of the equipment.

At the Highland Park plant of the Ford Company, he said, all maintenance and construction work, except electrical work and machine repair, comes under one head. This includes millwright work, plumbing, steamfitting, painting, glazing, track construction, carpenter work, tinsmithing and the fabricating shop. The factory is divided into five territories with a competent man, who is responsible for all the work done in that territory, in charge of each one. This simplifies the work and two foremen do not cover the same ground. The methods of doing work, the time taken and the cost of one foreman may then be compared with the others.

In the fabricating shop, everything is built, from structural steel to a stock box. All equipment, such as conveyors, ovens, benches and tanks, for all branches throughout the United States, and foreign countries, is made in this shop. An average of 30 tons of steel is used each day. If a conveyor or an oven is made for Memphis with a capacity of 300 cars per day, the same oven or conveyor is built for Manchester, England, or Buenos Aires, if the same production is wanted; or it may be lengthened or shortened to suit the requirements. In a large factory, maintenance, he said, can best be handled by one maintenance head. The men can then be divided more efficiently and the work can be done more economically.

Fire Protection

Every minute of a service-man's time when on night duty should be spent in patrolling the plant, to prevent fires from starting and to detect air, water, steam or gas leaks. Hourly patrol is wrong, because a fire may get beyond control before being discovered. At the Ford plant the buildings are patrolled every 6 min. by men on bicycles who pull boxes at

certain points. No serious fire has occurred in 12 years. The 12 men in the centrally-located fire-department are on duty at all times and work on production when not on duty as firemen.

Cooperation, said Mr. Remington, should be developed between the maintenance department and the department heads. Time lost or money wasted through lack of cooperation cannot be measured and should not be tolerated any more than any other form of disloyalty or dishonesty.

Illustrating his paper with numerous views of the Ford plant, Mr. Remington showed various types of equipment used in maintenance work, such as horses, scaffolding and nets used in painting, trucks for moving machinery, a single and a double-section hoist for installing lineshafting, a special horse for this same purpose that is used where the space is limited, a belt-cutter, and standard 2 x 8-in. planks used on scaffolding. Nets, he said, give painters a sense of safety when working high above the ground and enable them to do more work. When one of the painters was asked to illustrate the use of the net at the time the photograph was taken, he immediately fell backward without hesitation and landed safely in the net.

The Moving of Machinery

Fifteen gangs do nothing but move machinery, each gang having its truck. So far this year, Mr. Remington said, 9200 machines had been moved. Five-inch rollers are used, this being the height of the truck platform above the floor. Only 8 machines out of the 9200 had been damaged in moving, though some were moved from one floor to another. As much as 15 tons has been handled on one truck.

Moving a department means moving from 40 to 50 machines. Indicative of the importance of seemingly negligible amounts of waste, instructions were given recently to collect the small pieces of belting, from ⅛ to ⅜ in. long, that remained on the floor about four machines during a period of 3 days, after the ends of belts had been trimmed. By checking up the requisitions it was found that the waste of belting amounted to $22.80 per day. A belt-cutting machine that prevents this waste costs from $12 to $15.

Regarding the saving that may be effected in belting, W. W. Nichols, in opening the discussion, stated that during a belt survey made several years ago many machines were found to be overbelted, some underbelted.

Outlining an organization that will take care of every detail that might arise in a large production plant and dispose of it with the least possible delay to production, L. A. Blackburn, plant engineer of the Olds Motor Works, in a paper entitled Organizing for Plant Maintenance Work, discussed the scope, function and obligations of all the various lines of activity of the plant and the relations of the departments to one another, with a view to securing successful cooperation and the maximum production. His paper is presented in full on p. 440 of this issue of The Journal.

Emergency Repairs

Defining an emergency repair as a repair that will last until a permanent one can be made, such as the replacement of a shear pin, Mr. Blackburn said the new part is put in and later is replaced by one that is suitable for the purpose. A special man is used in belting repairs, who is familiar with sizes, material and the like. Every repair that must be made is followed by a report as to the reason for the breakdown, if it is due to faulty conditions.

To get the job going as soon as possible is the thing to do, said Mr. Remington. If the part is faulty it is redesigned. To many persons a belt is merely a belt, but it is not. After a belt has been put on, a record is kept of the actual number of hours before it gives out. Then another belt is tried. Each card shows the results of two tests. So far as possible new equipment is tried out and checked with old.

Safety work, Mr. Blackburn believes, should come under the plant maintenance engineer because of the qualifications that he is supposed to have. The difficulty usually is not lack of safety guards but failure on the part of the employe to use his head. He must know how, where and when to guard to prevent accidents. The personnel department is not mechanical and confines itself to living conditions and the like.

Ford Methods

Mr. Remington, when asked his opinion, replied that a great many methods of the Ford plant are not being used in other plants. The Ford plant has found out, he said, that if the safety engineer is to accomplish anything he must have almost the entire plant back of him. Unless his recommendations are acted upon immediately it is likely that the existing conditions will not be remedied. The safety department can shut down any department at any time. Any man who is found to be careless spends 2 or 3 days in the safety office looking at safety pictures. Some men plead to be allowed to go home but they are there to look at the safety pictures and have no chair to sit on, either.

The maintenance department does more than maintain the plant. No department in any organization turns out better men. They should have a knowledge of how all things should be done. Considerable work is done that is outside the plant in other cities. It takes a man with brains to handle the job. It is handled like that of a contractor. Sending foremen to other cities gives an opportunity to find out what kind of men are in the department. The Ford Company does not buy a machine until it is properly guarded with safety devices.

No employe of the Ford Company is allowed to smoke anywhere on the property at any time. Nor are cuspidors provided. If a man feels that it is necessary to expectorate he must check out and go outside the plant.

T. J. Litle, Jr., of the Lincoln Motor Car Co., presided at this session.

MORE DURABLE NICKEL PLATING

Improvements in Processes; Essentials for Greater Service; Suggested Tests

F. A. Cornell

Nickel-plating methods and tests for the durability of plated surfaces was a subject that held the interest of more than 100 members and guests during a 2½-hr. session. The meeting was notable for the great number of questions asked concerning the details of various processes and tests and for the explicit information that was willingly given in reply. Forty-six question cards were returned and these were supplemented by many questions asked orally. Under the inspiring and snappy leadership of F. A. Cornell a vast amount of experience had been recorded and at the closing time those present seemed loath to depart. W. H. Graves, of the Packard Motor Car Co., and W. M. Phillips, of the General Motors Corporation, were the speakers, Mr. Graves describing new processes recently installed at the Packard plant, while Mr. Phillips paid particular attention to tests for durability.

The three real problems that they had started out to solve, said Mr. Graves, were rusting, pitting and peeling. To determine the amount of improvement produced in overcoming rust a test was necessary. The most satisfactory one, he said, seemed to be the salt-spray, in which a 20-per cent salt solution is atomized by an atomizer and in the vapor the nickeled

parts are placed. Two radiator shells, besides many smaller parts, can be tested at one time.

Peeling is caused by rust or grease that has not been removed from the part before plating. When the shell is dipped into cold water before plating, if the water-film does not break, the indication is that the shell is free from grease and is sufficiently clean for proceeding with the plating.

The equipment for the nickel and copper plating consists of moving-cathode, pitch-lined wood tanks. These vary in size according to the quantity of production, the nickel tanks being the larger because the parts are left in them longer. Other tanks are steel or lead-lined, steel being used for alkaline solutions and lead for acids. The tanks are about 5 ft. from the floor and the men work on a platform about one-half that height.

Advantage of Moving Cathodes

With moving cathodes a definite time-cycle is obtained, all parts being subjected to treatment for the same length of time; the deposit is uniform, for each piece goes past the same anode; the slight agitation produced gives a smoother finish with high current-density and leaves the surface free from pits; and the current can be more easily controlled.

A nickel-plating process consists of (*a*) polishing, (*b*) cleaning, (*c*) copper plating, (*d*) buffing and cleaning, (*e*) nickel plating and (*f*) buffing. Real quality in plating begins with the polishing. The surface must be smooth. If marks are left, the buffing will cut through the copper and nickel plating and cause serious difficulties. The sequence of the five operations of polishing comprises one with No. 70 emery, one with No. 120 and three with No. 150, each being at right angles to the last preceding one.

Cleaning is important because it prevents peeling. Then follow washing in cold water, a bath in 10-per cent hydrochloric acid, more cold water, a bath in a 3-oz.-per-gal. solution of sodium cyanide, more cold water, benching and brushing with pumice especially in the corners, and finally a return to cold water. If the part comes out clean it is ready for copper-plating.

Copper-Plating

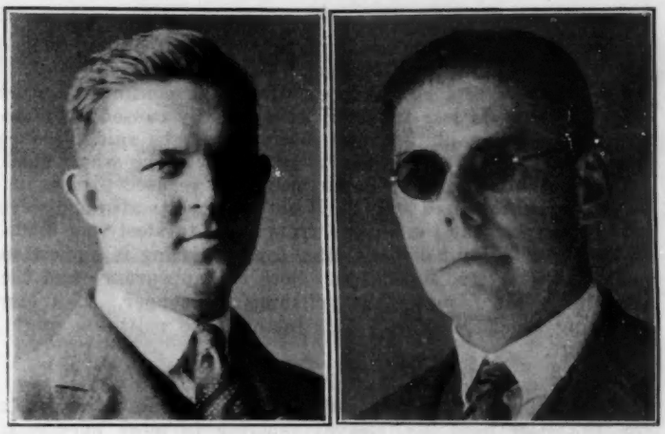
Copper-plating fills the polishing marks and low spots. It is applied in a moving-cathode tank having a current-density of from 25 to 30 amp. per sq. ft. for 17 min., or a total of about 425 amp-min. This is 12½ times the ampere-minutes formerly used and is from 2½ to 7 times that in general use. This high rate of deposition deposits more copper and much more uniformly, the result being less buffing through and better rust resistance. In producing a solution to carry this current, more salts and copper were added, bringing the copper-content up to 5 oz. per gal. Although old platers had said that so high a current-density could not be used, no trouble has been experienced; the plating will withstand the salt spray four or five times as long as it would formerly.

After another thorough buffing the part undergoes another thorough cleaning, the same as before, with the exception that the hydrochloric acid bath is omitted. The shell is dried off in hot water before going to the buffing room.

Nickel-Plating

In the nickel-plating operation the current-density has also been increased but not so much as in the copper tank, for the reason that the motor-generator in use would not give so much current and because of difficulties encountered. Eleven amperes are used, as against 2 that were used before, for 40 min., or a total of 440 amp-min. This means a deposition of 5.5 times as much nickel in the same time. The general practice is to use 60 to 80 amp-min. The chief advantage obtained is the prevention of rust. The expense of replating cut-through parts has been reduced about 88 per cent. Whereas previously care had to be taken not to hold the shell too tightly to a 10-in. wheel, now a 14-in. wheel is used and the buffing can be done faster and better.

To get good results in nickel-plating, the surface to be plated must be polished smooth, it must be thoroughly cleaned, plenty of copper must be applied, the surface must be cleaned well again, plenty of nickel must be put on, and



W. H. Graves W. M. Phillips

exact knowledge must be had of the composition of the solutions.

In replying to questions brought out in the discussion, Mr. Graves contributed the following additional information. Cathode tanks, he said, are used only for the radiator shells and the rim plates; barrel-plating with the same current-densities and the same solutions is used elsewhere. In barrel-plating, although some rust appears on the threads after the 24-hr. salt-spray test, the exposed surfaces are almost entirely free from rust. The buffing, he said, was entirely hand work. About 10-lb. per sq. in. pressure, he added, is used in atomizing the salt spray.

To the query of R. S. Hopkins, of the Hudson Motor Car Co., whether the solutions are controlled by the laboratory or by the foreman, Mr. Graves replied that they were controlled by the laboratory. Beginning with a single nickel-salt solution, this is neutralized by adding ammonium carbonate; consequently they got a double nickel-salt solution; analyses are made, one each week, and oftener if necessary.

Points Developed in the Discussion

The nickel-content is held to 5 oz. per gal., said Mr. Graves. The current is applied to the whole group of shells and is kept constant by resistances that are varied inversely with the number of shells. All the rinsing is done in the same tank but the water is changed so often that no danger of contamination arises. No experimenting has been done on zinc-plating, he said. The inside of the shells show rust because it is not buffed nor is it cleaned so well. The solutions are not filtered but are kept clean by controlling the acid-content. A concentration of 3 oz. per gal. is used in the cyanide cleaning solution, that quantity generally being strong enough to neutralize any acid that might be present, yet not strong enough to do harm. Too strong a solution causes blisters. The amount of solution that is saved by the use of moving-cathode tanks will depend on the amount of production. Moving tanks are good if production warrants continuous operation. Nickel solutions are cold; copper solutions, hot. No particular thickness of nickel-plating is attempted. If the 24-hr. salt-spray test shows a good coat of nickel, the results are considered satisfactory.

Mr. Gilchrist remarked that a zinc coating is expected to withstand from 60 to 75 hr. of salt spray and that in comparison 24 hr. was not long. Zinc, he said, deposits faster than nickel. Theoretical deposits of metal very seldom agree with actual deposits.

Mr. Graves averred that 440 amp-min. of current will deposit more metal than will 50 amp-min. To this Mr. Gilchrist agreed. Replying further to the question cards, Mr. Graves answers conveyed the information that the nickel solution is heated to avoid trouble from pitting; that the salt-spray 24-hr. test corresponds to about 2 years of actual service, in other words, each hour of the test corresponds to 1 month of service; that the buffing of the copper has much to do with the quality of nickel-plating; that the results of

efforts to plate aluminum and aluminum alloys had been very unsatisfactory; that head-lamp rims made of aluminum had all come back and that brass had been substituted.

Salt-spray tests run fairly uniform, he continued. Rust that appears in less than 24 hr. is usually caused by a defect. Cadmium plating was discontinued, he said, because cadmium could not be made to spread over the whole shell. At first the engineering department had refused to consider using a nickel-plated steel shell but the results attained were so wonderful that the change from brass to steel was made. The necessity for polishing after copper-plating is a question of appearance and durability. Both the appearance and the durability are improved by polishing the copper. If a less pleasing appearance were satisfactory, the polishing might be omitted.

Function of Copper-Plating

Copper-plating serves to fill up the polishing marks left on the steel, said Mr. Graves replying to more questions. When polishing marks can be seen through the nickel-plating, rust will be seen to appear on top of those marks. Shells are color buffed in the nickel before undergoing the salt-spray test. Leaving off the last two polishing operations and substituting a heavy copper-plate, Mr. Graves thought, would make a very poor job. Copper follows the contour of the metal and is deposited on the top as well as at the bottom of the crevices. Before the salt-spray test, the shells are washed with gasoline to remove all grease, finger prints and the like. If they were greasy no rust would appear on them at all. If the copper should be cut through in buffing, the shells are put through the same tank again. Sludge depends largely on the purity of the anodes.

Mr. Gilchrist believed that cast anodes form sludge. He said discoloration of the iron in the solution could be avoided by adding sulphuric acid.

The maximum allowable free acid in the electrolyte of the nickel tank, according to the Wedge comparator, is 5.6 to 6.0. This is called the PH number, continued Mr. Graves. The purpose of the cyanide solution is that of a neutralizer. The 5-per cent salt solution, he said, had not been used, the 20-per cent solution being in accordance with the standard specifications of the American Society for Testing Materials.

Mr. McIntosh, of the Reo Motor Car Co., said that he was able to get a little faster reaction by using the 5-per cent solution. It is used in an enclosed box with a tilting base and lid.

Formulas for Solutions

A request for the fomulas used for the solutions brought the reply from Mr. Graves that the 2000-gal. tank of copper solution contained 4.5 to 5.5 oz. of copper, 0.2 to 0.5 oz. of free sodium cyanide and 5.0 to 8.0 oz. of sodium carbonate per gal. The current density is 25 amp. per sq. ft. at from 4 to 6 volts. The temperature is between 150 and 160 deg. fahr.

In the nickel tank the solution contains 10 oz. of double nickel-salts, from 23 to 25 oz. of single nickel-salts, from 2 to 3 oz. of sodium chloride and from 2 to 3 oz. of boric acid per gal. The current density is 11 amp. per sq. ft. at from 4 to 6 volts. The temperature is that of the room; the time, 40 min. The PH number is 5.6 to 6.0.

The muriatic pickle is used in a lead-lined tank and contains 10 per cent of cold muriatic acid. The lead lining lasts from 1½ to 2 years. The nickel solution tends to become alkaline and is kept about 5-5 by adding boric acid.

Mr. Gruenfeldt, referring again to the salt-spray test, said that, in his opinion, thickness of plating had nothing to do with the length of time that nickel-plating could withstand the action of the salt, but that the absence of porosity was the governing factor. Thickness of film, he said, is necessary only to reduce the porosity. Without porosity the thinnest film would be absolutely protective against the rust produced by the salt spray. Polishing is a factor only in so far as it assists in closing up the pores, because of a certain spinning action. A thick layer is merely extra thin layers added, so to speak; they tend to close up some of the pores that exist in a thin layer.

John McGeorge, of the Oakland Motor Car Co., recalled that many years ago in London copper locomotive-boiler tubes were made by electro-depositing copper on a mandril and at regular intervals a rolling forward and back on the mandril for the purpose of closing the pores. Mr. McGregor, of the Ford Motor Co., could remember when what was called duplex copper was used in bicycles. The handlebars and sprockets were nickel-plated, buffed and nickel-plated again. When put on the roof for a year they showed no signs of rust. The nickel was buffed to fill up the pores. When nickel plating was first used, said Mr. Graves, the principal object sought was a bright luster; now the efforts are toward making it endure.

Durability of Plated Surfaces

In presenting his paper, Mr. Phillips considered principally the features of nickel-plating that tend toward durability. His paper is printed in full on p. 461 of this issue of THE JOURNAL. The first question asked in the discussion of the paper concerned the ratio of the labor cost to the total cost of nickel-plating a radiator shell, for example, Mr. Phillips having stated that if two of the polishing operations were omitted, 18 cents would be available for extra plating.

Mr. Phillips replied that doubling the thickness of the plating would add probably 10 cents to the cost; the polishing cost is approximately 60 cents; but costs vary with the shop and the nature of the apparatus.

Other queries brought out the information that the filtering of copper and nickel solutions is done while the tanks are in operation. The solutions are filtered as often as may be necessary, this depending to some extent on the time of the year, the amount of operation and the like. It is required more frequently in summer than in winter. Controlling the acidity of the nickel bath is very important, and is done oftener than once a day. Doing so prevents the accumulation of slimes, particularly nickel hydrate and ferric hydrate. The necessity of filtration arises from two general causes: (*a*) the by-products of the processes in the tank and (*b*) external mechanical dirt. Automatic polishing-machines are feasible when the production is large.

Value of Salt Spray Test

The value of the salt-spray test on brass and zinc alloys, said Mr. Phillips, is not so great as on steel. On zinc it gives a white stain corresponding to the brown stain of iron oxide. Shortening the polishing or buffing of brass serves only to make the operation more difficult, for nickel is harder than brass. Two or more deposits of nickel would increase the durability, particularly if carried out under different current-densities. As the structures would be different, a staggering of crystal growths will give greater durability. The brightness of a nickel deposit indicates a closer grain and therefore better wearing quality.

Chairman Cornell's question regarding the comparative salt-spray passing point on nickel that would correspond with the 48-hr. point on zinc-plated rims elicited the information that a duration of 20 hr. was considered satisfactory. Two standards are aimed at, said Mr. Phillips, 10 hr. for the first appearance and 20 hr. for a general appearance of rust. Many steps in inspection, he continued, like those given at the 1924 Annual Meeting by Professor Baker, depend entirely on the personal factor and are interpreted differently by different persons. The tests by salt-spray are not uniform but show variations when used with steel, wrought iron and cast iron and even with the same pieces if they are composed of sheet metal.

Acid Test

Mr. Gilchrist described an acid test used by the Remington Typewriter Co. that in results approximates very closely to the salt-spray test but is very much quicker. The test consists merely of painting on a little of equal parts of sulphuric acid, nitric acid and water, and noting how long a time is required for the acid to eat through. A heavy deposit that

(*Concluded on p.* 467)

AUTOMOTIVE RESEARCH

The Society's activities as well as research matters of general interest are presented in this section

THE MUSIC OF THE GEARS

Noise Among Gear Problems Discussed by Experts at Informal Dinner-Meeting

All automotive engineers agree that gears present many of the most complex problems that confront the industry. And if one can judge from the trend of informal discussion that took place at the dinner-meeting on Oct. 22 arranged in Detroit by the Research Committee, the oustanding problem is that of noise. Various factors relating to gear noise and other unsatisfactory features of performance were considered in a very informal way by about 25 leading representatives of the automotive and allied industries.

It is planned to present a detailed account of the meeting in these columns at an early date. The following brief resume of the discussion may, however, be of interest at this time.

Chairman Litle asked Chairman Horning of the Research Committee to relate his experience in the construction of engines. Mr. Horning stated that in his opinion faults which are oftentimes assigned to gears should in reality be laid at the door of other elements, such as crankshafts of insufficient rigidity, bad distribution, improper assembly of gears and inaccurate spacing between centers. He reported an interesting study of gear noise in which an oscilloscope revealed the fact that the crankshaft buckled considerably. It was decided that the only forces capable of causing this deflection were those that might arise from bad distribution. The installation of a suitable manifold proved this conclusion to be correct and the difficulty was at once remedied.

Lubrication of the front-crankshaft bearing was said to be very important so far as gear noise is concerned. Forced-feed lubrication was recommended for this point. Mr. Horning estimated that practically 40 per cent of the engine rejections from the test room arise from gear troubles. He called attention to the fact that engines that are continually under load have greater durability and exhibit more satisfactory performance than is the case with engines that are intermittently loaded and that have frequent periods of idling. An example of an engine that ran 125,000 miles in truck service where the load was fairly constant and continuous was cited; in this instance the bearings required absolutely no attention.

K. L. Herrmann, Studebaker Corporation of America, believed that an opportunity exists for considerable improvement in transmissions, but as yet no gear is made that is entirely satisfactory for this service. He cited the rear-axle gear as being reasonably quiet and wondered why it is so difficult to obtain equally quiet operation for the transmission. He stated his conviction that timing-gears can be made to function as quietly as the chain. In conclusion Mr. Herrmann recommended that the gear situation be studied more carefully and that many of the problems now awaiting solution by the car builders be solved by the gear manufacturers instead.

Earle Buckingham, Pratt & Whitney Co., reported briefly concerning the progress of the American Society of Mechanical Engineers committee of which he is vice-chairman. A gear-testing machine is being built by which it is planned to study the effect of errors in spacing, profile and the like of gears. Upon the completion of this machine, tests will be conducted at the Massachusetts Institute of Technology.

Mr. Buckingham spoke very interestingly of his study of characteristic musical tones or intervals between the tones as determined by the toothing of gears. It was found that a transmission which gave the least trouble was characterized by intervals that were harmonious from a musical standpoint; for example, the interval between the constant-mesh gear and the second speed was a minor third. The troublesome gear combinations were found to give bad discords. This investigation was applied to the gearing arrangement of the entire car with very interesting results which showed unmistakably that gear combinations which emitted harmonious musical notes were much more pleasing to the ear and less tiring than the inharmonious examples.

C. H. Sterling, General Motors Research Corporation, emphasized the importance of adequate lubrication and of proper alignment of gear-carrying members. He mentioned studies of noise that are being made by his organization by both electrical and audition methods.

J. H. Nelson, Wyman-Gordon Co., classified the subjects of importance in the consideration of gears under the headings of rigidity, distortion, alignment and accuracy. He spoke of the importance of forging gears in such a manner that the material is uniformly distributed and the grain structure is uniform throughout the entire periphery of the gear.

Among those who discussed various phases of the gear situation, whose remarks will be reviewed in a later issue of THE JOURNAL, were H. E. Blood, Detroit Gear & Machine Co.; W. L. Carver, *Automotive Industries;* K. H. Condit, *American Machinist;* B. J. Lemon, United States Rubber Co.; Glenn Muffly, Lees-Bradner Co.; A. L. Nelson, consulting engineer; Erik Oberg, *Machinery;* L. D. Spence, Brown & Sharpe Mfg. Co.; R. M. Williams, Packard Motor Car Co. Others who attended the meeting were Gould Allen, Brown-Lipe Gear Co.; A. B. Bolender, Warner Gear Co.; E. A. Garvin, Cadillac Motor Car Co.; W. H. Watkins, Hudson Motor Car Co.; and C. F. Clarkson, R. S. Burnett and J. A. C. Warner, Society of Automotive Engineers.

A TERNARY-ALLOY BEARING-METAL

The Development of a Material with Unusual Wearing Qualities

The use of bearings in industry today is of so much importance that we may say that no machine is stronger than its weakest bearing.

If we trace back the history of bearing material, we find that iron appears to have been used first. Mention is made of its use in axles for chariots at the time of the siege of Troy about 1184 B. C. From that period until the 17th century A. D., there seems to have been little progress, and iron was still used as a bearing metal until 1839 when an Englishman, named Babbitt, developed a tin, antimony and copper bearing metal that he called an "anti-friction compound especially adapted for lubricated bearings of machinery."

In 1871 it was discovered that bronze had some properties that made it superior to babbitt as a bearing metal. It is harder than babbitt and withstands wear much longer. Bronze as a bearing metal has gone through various stages

of development, the recognized standard being the copper, tin and lead composition.

Since all classes of machines have bearings of some type, a correct design and the selecting of the right material are essential for efficient service. In consideration of the work a bearing is expected to do and the disadvantages under which this work is accomplished, the development of a bearing metal with good anti-frictional properties, capable of standing up under heavy loads at high speeds without heating, having sufficient compressive strength to eliminate the danger of squeezing out of place and at the same time not liable to crack or break when subjected to sudden shocks, should prove of more than ordinary import to those interested in bearing service.

Credit is due the Bureau of Aeronautics, U. S. Navy Department, for bringing to light the merits of a hitherto little-known bearing metal and developing it to the extent that it is being adopted for all aircraft engines in use by the Navy.

Composition and Physical Properties

The material is described as a homogeneous alloy of the following composition:

Tin, per cent	4.5	6.5
Lead, per cent	21.0	25.0
Copper	Remainder	

The physical requirements usually specified are as follows:

	Pig Metal	Castings
Ultimate Strength, lb. per sq. in., min.	20,000	20,000
Elastic Limit, lb. per sq. in., min.	12,000	12,000
Elongation, per cent in 2 in., min.	15	10

The quality of pig metal or castings when broken for fracture tests must show a uniform composition, distribution of the lead throughout must be uniform and the metal must show no evidence of serious segregation of the lead. The Navy also specifies that it must be possible to heat the metal to a temperature of 1200 deg. fahr. without evidence of the lead sweating out. This test should be accomplished by gradually bringing a sample of the metal up to this temperature and scraping it at intervals with a knife blade.

Successful founding of this metal requires that the following rules be observed: keep core soft; keep sand dry; keep well covered with charcoal until solution point is reached; do not stir with an iron rod; either graphite or nichrome should be used, preferably graphite; pour at the correct temperature.

The machining of this metal is comparatively easy, and best results are obtained by using a sharp cutting tool.

Attention is called to the fact that expansion occurs in more than one direction, and it is therefore necessary to allow sufficient clearance for this property, the recommended practice being from five to seven thousandths of an inch on a 3 in. diameter. Remelting or working does not change the properties of this metal.

Effect of Poor Lubrication

In the past it has been necessary to pay especial attention to the lubrication of bearings. With this material an insufficient amount of oil seems to have little effect on the bearing. This statement is not intended to imply that lubrication may be eliminated; only that, if for any reason the oil supply should become inadequate or cut off temporarily, the bearings would not be materially affected. As would naturally be supposed from the composition, due to the high percentage of lead, there is an increase in weight over the other bearing metals, but the wearing properties are of so much more importance that it is hardly necessary to consider this point.

Practical Applications of This Metal

Some uses that have already been made of this metal are as follows: main shaft bearings, water-pump bushings, valve-stem bushings and thrust washers on clutch mechanisms in automotive work; connecting-rod bushings and main rod bearings in locomotive work; burr wheel pins for pulp grinding machinery in paper making; loose pulley bushings to replace roller bearings; paper-cutting machinery bearings; machine-tool bushings; pitman brasses for nail machines and armature bearings in street railway work.

In connection with the uses of this material, it is interesting to note what Lieut. Bruce G. Leighton of the Bureau of Aeronautics, U. S. Navy Department, has to say concerning the Wright-Navy development work on aircraft engines, in his paper that appeared in *Automotive Industries*, April 26, 1923. It is as follows:

> In this one year of development, the life of the connecting-rod bearings has been increased from less than 100 hr. at reduced power, to 572 hr. at full throttle. At the end of this period they were apparently in need of no new repairs or adjustment. This same type of bearing has been used with excellent success in other models of engine and is being adopted for all aircraft engines in use by the Navy.

The ternary alloys have not been thoroughly investigated and in the past, tin-antimony-copper mixtures have been the most successful of this group. However, from the results already obtained, it is believed that intensive research work with this combination of alloys should prove of great value to those interested in bearing metals.

CONFERENCE ON ELECTROPLATING

FOR several years the American Electroplaters' Society has cooperated with the Bureau of Standards in the investigation of electroplating solutions and processes. Two meetings of its Research Committee have been held at the Bureau each year to dicuss the progress of, and the plans for, studies in this field. Valuable suggestions and information have been gained by the Bureau and the electroplaters have, in their turn, been assisted in the application of the results of research to industrial conditions. At these conferences it has been pointed out that the work of the Bureau might be made more valuable and useful if a larger number of those interested in plating were better acquainted with the methods, results and applications of these researches.

Following a recommendation of the Committee, arrangements have been made for a meeting and conference at the Bureau of Standards on Nov. 14 and 15, to which all platers, chemists, superintendents and other factory officials, dealers in platers' supplies and others interested in electroplating are invited. At this meeting an opportunity will be afforded to visit the laboratories of the Bureau, especially those devoted to electro-deposition. Previous and current researches of the Bureau, especially on nickel deposition, will be discussed at the sessions. Suggestions are also invited upon subjects for future researches and methods by which the Bureau can cooperate with the Electroplaters' Society and with the manufacturers to foster the acquisition and application of knowledge in the plating industry. In order that suitable arrangements can be made for a meeting place, those who expect to attend the conference should notify Dr. William Blum at the Bureau of Standards, City of Washington.

TENTATIVE STANDARDIZATION WORK

Criticism of all tentative reports should be sent to the Standards Committee in care of the Society

RIGID BRAKE-DRUMS REQUIRED

Distortion of Brake-Drums Made to Present S.A.E. Standard Decreases Brake Efficiency

The need for revising the present S.A.E. Recommended Practice for Passenger-Car Brake-Drums, p. F1f of the S.A.E. HANDBOOK, is well brought out by John R. Cautley, of the Perrot Brake Corporation, in a letter recently sent to the Society. Mr. Cautley's comments, which are given below, have been referred to the Axle and Wheels Division and to the former Subdivision on Brake-Drums for consideration.

JOHN R. CAUTLEY

The members of the Brake-Drum Subdivision are E. R. Jacobi of the Hayes Wheel Co., chairman; R. J. Burrows, of the Clark Equipment Co.; F. C. Burkhardt, of the Crosby Co.; J. R. Cautley, of the Perrot Brake Corporation; L. J. Fralick, of the Midland Steel Products Co.; G. W. Harper, of the Columbia Axle Co.; J. S. Schneider, of the Bossert Co.; A. Van Halteren, of the Motor Wheel Corporation, and G. L. White, of the Federal Pressed Steel Co. Mr. Cautley's comments follow:

> We feel strongly that the question of standardization on brake-drums should be reopened. Our analysis of the situation is as follows:
>
> First, the present standards were developed for two-wheel brakes, where the vital factor was the outside diameter of drums. This was for the reason that the external-contracting brakes were in most cases used for the service brakes, and therefore, the internal diameter was of secondary importance. This is shown by the fact that brake-drums of 12, 14 and 16-in. outside diameters are easily obtainable. However, it is very difficult to get drums of the S.A.E. Standard inside-diameter, as the wall thickness is usually less than standard.
>
> Second, no provision is made in the standards for machined drums or for flanged drums. Machining and flanging are rapidly becoming important factors.
>
> In reopening the subject, consideration must be given to the following new and vital considerations.
>
> First, four-wheel brakes are here to stay.
>
> Second, with the widespread interest in braking now evident, engineers are beginning to realize the value of properly protected brakes. External brakes cannot be properly protected; therefore, internal brakes must be used. This means that the internal diameter of the drum becomes as important and will become more important than the external diameter.
>
> Third, unless complicated power-mechanisms are resorted to, the power available for braking is still the power of the driver's leg. We have called the public's attention to the poor quality of brakes in general, and it is demanding better brakes. This means that it is demanding the maximum stopping-power available with four-wheel brakes, with less pedal pressure than when all the power was utilized for applying two-wheel brakes. Not only this, but a longer period between adjustments is being called for.

Realizing these new factors, what is the way to meet the public demand? Simply by increasing the efficiency of the system by better design and construction methods.

It is common knowledge that in many cars even with two-wheel brakes there is an excessive amount of pedal travel before the brake is actually applied. This pedal movement simply means that the pedal is engaged in taking up the slack in the brake, due to clearances necessitated by tolerances in *various* parts. This waste pedal-movement affects the efficiency of the system materially because, when it is possible to reduce the pedal motion required for a given movement of the brake actuating means, we can increase the leverage, and therefore reduce the pedal pressure for a given braking effect.

Further, some pedal motion is caused in actual braking service by drum distortion. Part of this motion may be useful work but the fact that it is caused by drum distortion means reduced rather than increased braking effect.

On a car which we have been working with, using standard drums, i.e., 14-in. diameter, 3/16-in. wall drums without flanges, and with drums and brake-shoes very carefully machined and adjusted, it was found possible to distort the brake-drums during brake actuation by an amount which increased the diameter on the horizontal axis by 1/16 in. and decreased the diameter on a vertical axis by the same amount. Taking the leverage from pedal to brake-shoe on this car, which is 10 to 1 and, taking the tolerances for eccentricity and variation in diameter of the S.A.E. Standard drums as being 0.01 and 0.02 in. respectively, we find that to take care of the above tolerances and distortion, more than 2 in. of useless pedal-movement is necessitated.

The above is a concrete illustration of how eccentricity variation in drum diameter and distorton affect the efficency of a brake system.

We feel very strongly, therefore, that the subject of brake-drum standards should be carefully studied from a new point of view. By bettering brake-drums at an increased cost which will be measured in cents, the industry will not be forced to use expensive and complicated power-mechanisms which will run into the dollars column. With the internal brake rapidly advancing to the point where it will become much the most popular type, standardization of the internal diameter will enable makers of brakes to standardize on a small number of sizes, thus keeping the cost of the internal brake down.

For these reasons, we believe that the following points should be taken up in about this order:

(1) Standard diameter of drums for internal brakes. The internal diameter to be the

governing factor, even when internal and external brakes are used
(2) Eccentricity of bore allowable
(3) Variation of cylindricity allowable
(4) Machining of drums, question of whether they should be machined on the hub, or off
(5) Flange to prevent distortion in brake as opposed to the use of heavier stock in the drum
(6) Standard depths of drum by constant fractional variations

The first five of these points we are particularly interested in as we believe them to be of vital importance. The sixth we are in favor of, due to the fact that we cannot see how it would restrict manufacturers if the drum depth or height varied by standard increments of ¼ in.

NEW SUBDIVISION APPOINTED

Specifications for Leather Substitutes to Be Given Consideration

As the Passenger-Car Body Division believes that a definite classification of a few grades of leather substitutes and methods of test that can be used to determine the quality and durability of leather substitutes will be of considerable value to both manufacturers and users, a Subdivision has been appointed to develop such specifications. E. H. Nollau, chemical superintendent of the Fabrikoid division of E. I. duPont de Nemours & Co., has been appointed chairman. The other members are E. K. Files, of the Duratex Co.; L. E. Carpenter, of the Zapon Leather Cloth Co.; R. C. Bowker, of the Bureau of Standards; K. L. Childs, of the Fabric Body Co.; and H. C. Mougey, of the General Motors Research Corporation.

At the last meeting of the Passenger-Car Body Division a discussion of the need for standardization brought out the following points:

At present leather substitutes are bought entirely on the basis of appearance and price, without regard to durability and the proper quality for each particular application.

Many of the products now on the market are of inferior quality and consequently low in cost. The use of such material for applications where better material is absolutely necessary reacts against the use of leather substitutes. This condition could be overcome by developing reliable means of distinguishing between different grades of material.

It has been estimated that over 30,000,000 combinations of grades, types, dimensions and finishes of material are possible and that an astonishingly large percentage of these has already been produced for the industry.

SPRING-EYE BUSHINGS

List of Over 200 Bushing Sizes Indicates Need for Standardization

The Bridgeport Brass Co. recently compiled a list of spring-eye-bushing sizes that are apt to be ordered. Although the list probably included bushings for other than current models, over 200 sizes were given, or omitting lengths, over 40 different combinations of inside and outside diameters. Standards for spring-eye-bushing dimensions have not been adopted by the Society, although it has recommended that the nominal wall-thickness should be ⅛ in. for all sizes. The situation brought out by the Bridgeport Brass Co. was referred to the members of the Spring, the Passenger-Car and the Truck Divisions for comment. The replies were in general in favor of the standardization of inside and outside diameters and, in some cases, of lengths. Several of the comments indicating the desirability of such a replacement-part standard are quoted herewith.

I know of no argument in favor of standardization which does not apply to spring-eye bushings. The cost of these bushings is a function of the size of the production unit. To make them at the lowest cost requires expensive machine-tool changes that take a good deal of time. Further than that, the advantage of being able to produce standard sizes in stock-runs will be very great. I cannot see the "restriction of individual design" argument in this case.

I do not believe that it would be desirable to draw from stock. This would be entirely satisfactory if our limits were similar to the limits of stock bushings. It is not reasonable to suppose, however, that every company using bronze bushings will specify the same manufacturing limits. This is due to the differences in the manufacturing facilities of the various plants—not saying anything about their methods of broaching, reaming and the like.

From the service standpoint it seems to me that an S.A.E. Standard for inside diameter and wall thickness would be very practical. Lengths, of course, will vary, but it would be a simple matter for any serviceman to purchase bushings of sufficient length to permit their being cut up into lengths that would fit each individual requirement, provided standard inside-diameters and standard wall thicknesses for them were adopted by the Society.

We believe that it would be well to standardize the inside and outside diameters and the lengths. This would not interfere with those who insist upon individual design, and it would benefit those who desire to avail themselves of the standardization. However, a great many parts, such as spring-hangers and shackles, as well as transmissions auxiliary equipment devices, require full-length bushings, whereas it is customary in spring manufacture and design to take a given width of spring and, following the present S.A.E. Standard, to finish the spring-ends to a width of 1/16 in. less than the nominal width of the springs. It seems that this would call for a double set of standards. Therein is the only real objection we can see to standardizing on definite inside and outside-diameters and lengths. Possibly, in considering this phase of the situation, it has been thought that the spring-makers could grind off the bushing after assembly, but, on the other hand, how about the service-stations when they are called upon to replace bushings? Will they appreciate the necessity for grinding off the ends of the bushings, or will they overlook the slight amount of bushing extending beyond the ends of the spring-eye? Is there not a possibility that the continual whipping from side to side will result in loose bushings, if they are not ground off on the ends?

It seems that this standardization could be accomplished very easily and that it would overcome a lot of the confusion that exists at the present time.

It certainly seems that the S.A.E. Recommended Practice for spring-eye bushings is too limited in scope, and that it should be extended to specify definite inside and outside diameters and lengths, as standard rather than as recommended practice. This will entail much less work than has been done on a great many other standards, although it may be found that standards will be needed for both rolled and cast bushings, the former having thinner walls.

CHROMIUM-SILICO-MANGANESE STEEL

As it is understood that a considerable amount of chromium-silico-manganese steel is used by the automotive industry, a Subdivision of the Iron and Steel Division has been appointed to formulate standard specifications if it shall be

found that the use of this steel warrants such recognition. In order that the Subdivision may have complete information as to the extent of the use of this steel, a questionnaire has been sent to all the steel manufacturers and to users. The data obtained will serve as a basis for the work of the Subdivision, of which L. A. Danse, of the Cadillac Motor Car Co., is chairman.

BRITISH ADOPT S.A.E. STANDARD

Charging-Plug and Receptable Dimensions Specified in British Standard

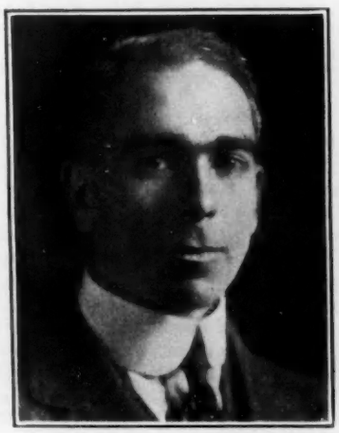
At the meeting of the Electric Vehicle Division in September, S. W. Attwell of the British National Physical Laboratory discussed with the members of the Division the present British Specification for Charging-Plugs and Receptacles recently adopted by the British Engineering Standards Association, this standard being in agreement with the present S.A.E. Standard.

Mr. Attwell stated that the British manufacturers have experienced trouble because plugs and receptacles, rejected because of a certain amount of eccentricity, would yet fit together and function properly. They had, therefore, established a concentricity tolerance of 0.005 in. which had been found satisfactory. As the Division members considered the action by the British manufacturers well founded, it was voted to revise the footnote on p. B101 of the S.A.E. HANDBOOK reading "Contacts must be accurately concentric to insure interchangeability" to read "The maximum eccentricity of contacts shall be 0.005 in." The runout as measured by an indicator would be twice this amount. The Division members were also of the opinion that it would be desirable to establish specifications for charging-plug and receptacle gages similar to those included in the B.E.S.A. Specifications.

Those present at the Division meeting, which was held in New York City, were A. K. Brumbaugh, of the Autocar Co.; E. L. Clark, of the Commercial Truck Co.; S. W. Attwell, of the National Physical Laboratory, London; S. C. Harris, of the New York Edison Co.; and Standards Manager R. S. Burnett.

FIVE TRUCK BATTERIES RECOMMENDED

S.A.E. Standard to Cover Truck as Well as Passenger-Car Storage-Batteries



W. E. HOLLAND

At the September meeting of the Storage-Battery Division the present S.A.E. Standard for Passenger-Car Storage-Batteries was extended to cover battery dimensions for heavy-duty motor-trucks. The present standard, extended as recommended by the Division and rearranged to avoid duplication, is given below.

The motor-truck battery sizes recommended are not intended for light-duty motor-trucks, the present passenger-car sizes being used for this service. The battery sizes recommended for heavy-duty motor-truck service will be found to meet the requirements of all the larger motor-trucks. The advantages of the standard proposed will be appreciated when it is realized that truck production schedules do not warrant the existence of special sizes of battery for truck makers, it being desirable to use a size that can be obtained readily from the battery manufacturers.

STORAGE-BATTERIES

S. A. E. Standard

Application.—These specifications are intended to apply only to lead-acid storage-batteries for automotive equipment.

Ratings.—Batteries for combined starting and lighting service shall have two ratings. The first rating shall indicate the lighting ability and shall be the capacity in ampere-hours of the battery when it is discharged continuously at the 5-hr. rate to a final voltage of not less than 1.7 per cell, the temperature of the battery at the beginning of such discharge being 80 deg. fahr. The second rating shall indicate the starting ability and shall be the capacity in ampere-hours of the battery when it is discharged continuously at the 20-min. rate to a final voltage of not less than 1.5 per cell, the temperature of the battery at the beginning of such discharge being 80 deg. fahr.

Location of Battery Parts.—The location and polarity of the terminal posts and the position of the handles and the name-plates shall be as shown in the accompanying illustration.

Terminal Posts.—When taper posts are used for terminals of lead-acid storage-batteries, the dimensions in inches shall be:

Small Diameter of Negative Post	5/8
Small Diameter of Positive Post	11/16
Taper per Foot	1 1/3
Minimum Length of Taper	11/16

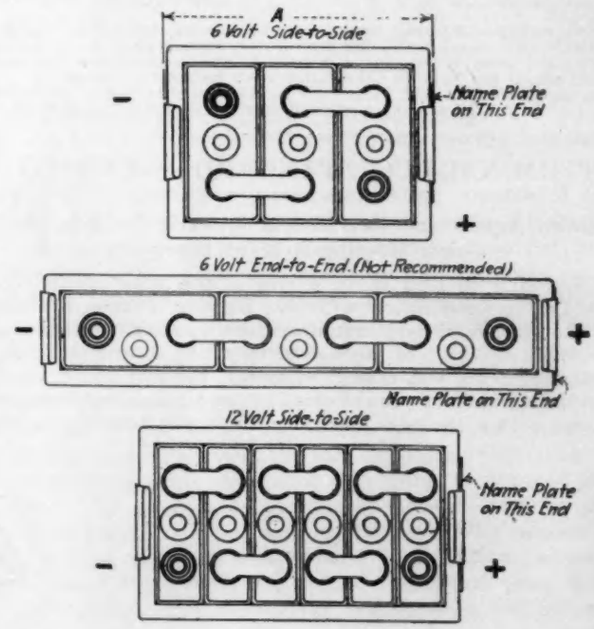
PASSENGER-CAR STORAGE-BATTERIES

Compartments.—Compartments for passenger-car starting and lighting batteries shall be of metal of not less than No. 18 U. S. S. gage (0.050 in.) and supported entirely by the chassis.

The inside width of the compartments shall be 8 in. and the height from the bottom shall be 10½ in. The inside length shall be 12, 13½, 14¾ or 18¾ in.

The battery shall rest on two wooden strips, each 2 in. wide and ¼ in. thick, running lengthwise of the compartment and positively spaced with the edges flush with the sides of the battery.

Hold-Down Devices.—Hold-down devices shall be attached at the top of each end of the battery case, not at the top of the handles. The diameter of the hold-down rods shall be ¼ in. The diameter of the rod holes in the hold-down devices shall be ⅜ in., and their centers shall be 3/16 in. from the ends of the battery case. Hold-down devices shall not extend more than 17/32 in. beyond each end of the battery case.



PASSENGER-CAR STORAGE-BATTERY DIMENSIONS

Battery No.	No. of Cells	Minimum Capacity, Amp-Hr.		Maximum Overall Dimensions, In.[1]		
		5-Hr. Rate	20-Min. Rate	Length (*A*)	Width	Height
1	3[a]	60	31	9 1/8	7 1/8	10
2	3[a]	72	37	10 5/8	7 1/8	10
3	3[a]	84	43	12 1/4	7 1/8	10
4	3[a]	96	50	13 1/2	7 1/8	10
5	3[b]	95	43	20 5/8	5 1/8	9 1/2
6	6[c]	36	19	12 3/4	7 1/8	10 1/8
7	6[c]	60	31	17 5/8	7 1/8	10

[1] The overall end-to-end length of passenger-car batteries for starting and lighting service includes handles, but not hold-down devices. The handles and the hold-down devices shall be attached only to the ends of the case. Terminals and connections shall not extend above the handles; the latter shall be the highest point.
[a] Arrangement of cells to be as shown in the top drawing.
[b] End-to-end assembly of jars shown in middle drawing is not recommended because of the inherent weakness of this type of construction.
[c] Arrangement of cells to be as shown in bottom drawing.

MOTOR-TRUCK STORAGE-BATTERIES

These specifications are intended to apply only to lead-acid storage-batteries for heavy-duty motor-trucks.

Compartments.—Battery compartments shall be of metal of not less than No. 18 U. S. S. gage (0.050 in.), and supported entirely by the chassis.

The inside width of the compartments shall be 8 in. and the height from the bottom shall be 11½ in. The inside length shall be 12, 14¾, 15½ or 18¾ in.

The battery shall rest on two wooden strips, each 2 in. wide and ¼ in. thick, running lengthwise of the compartment and positively spaced with the edges flush with the sides of the battery.

Hold-Down Devices.—Hold-down devices shall be attached at the top of each end of the battery case, not at the top of the handles. The diameter of the hold-down rods shall be 5/16 in. The diameter of the rod holes in the hold-down devices shall be 7/16 in., and their centers shall be ½ in. from the ends of the battery case. Hold-down devices shall not extend more than ¾ in. beyond each end of the battery case.

MOTOR-TRUCK STORAGE-BATTERY DIMENSIONS

Battery No.	No. of Cells[1]	Minimum Capacity, Amp-Hr.		Maximum Overall Dimensions, In.		
		5-Hr. Rate	20-Min. Rate	Length[2]	Width	Height
11	3	45	....	10 1/4	7 5/8	10 3/4
12	3	60	....	12 1/2	7 5/8	10 3/4
13	3	75	37	13 5/8	7 5/8	10 3/4
14	3	90	45	15 1/8	7 5/8	10 3/4
15	3	105	52	17	7 5/8	10 3/4

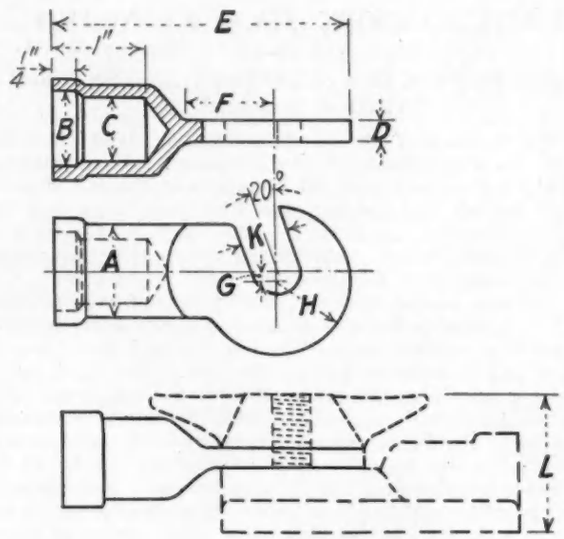
[1] Side-to-side assembly of cells shall be used as shown in the top drawing.
[2] The overall end-to-end length includes handles, but not hold-down devices. The handles and the hold-down devices shall be attached only to the ends of the case. Terminals and connections shall not extend above the handles; the latter shall be the highest point.
Batteries Nos. 11 and 12 are for lighting service only; batteries Nos. 13, 14 and 15 are for combined starting and lighting service.

TERMINAL-LUG STANDARD PROPOSED

Definite Agreement Reached at Electric Vehicle Division Meeting in September

Since early in 1922 H. M. Pierce of the Ward Motor Vehicle Co., in cooperation with the Electric Vehicle Division and the storage-battery manufacturers, has been considering the standardization of storage-battery tray terminals. The original proposal was submitted by Mr. Pierce about 2 years ago. As a result of several meetings and considerable correspondence this has been revised until it was possible at the Electric Vehicle Division Meeting on Sept. 26 to agree upon a definite recommendation.

The standard proposal is given in the accompanying drawing and table. It is not intended to cover the design of the entire terminal but only the lug dimensions affecting interchangeability. It is expected that the proposal will be submitted for action at the Standards Committee Meeting in Detroit next January.



Terminal Number	2	0	0000
Bolt	3/8-16	3/8-16	1/2-13
A	23/32	27/32	1
B	1/2	11/16	27/32
C	13/32	17/32	11/16
D	3/16	3/16	1/4
E	2 1/8	2 1/8	2 5/16
F	13/16	13/16	1
Min.			
G	3/32	3/32	1/8
H	5/8	5/8	13/16
K	7/16	7/16	9/16
L	1 1/4	1 1/4	1 5/8
Max.			

Bolts shall be made of steel and the thread shall be in accordance with the S.A.E. Free Fit (Class 2) Tolerances.

S.A.E. STEELS IN TEXTILE INDUSTRY

An interesting application of S.A.E. Steels has been indicated by a letter received from one of the textile-machinery manufacturers. According to this letter, very little attention has been paid to the analysis of steels used in the construction of general textile machinery. Steel is known only in terms such as "Soft Steel," "Dead-Soft Steel," "Hard Steel" and "Extra-Hard Steel." As all of these terms are open to interpretation according to the individual point of view, this situation leaves a great deal to the judgment of the purchasng agent and the supplier.

The writer of the letter mentioned indicated that his company will henceforth use the S.A.E. Specifications in purchasing steels.

Vol. XV November, 1924 No. 5

Coining-Press Operation

By A. R. Kelso[1]

Production Meeting Paper *Illustrated with* Photographs and Drawings

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

COINING-PRESS development is outlined and the author tells how such machinery was adapted to speed-up the production of automobile parts, such as forged arms and levers, by a squeezing process that superseded milling or spot-facing methods. The presses used are very rugged in construction and have the appearance of a plain-type punch-press, except for the knuckle that operates the ram. This knuckle is coupled to a crank by means of a connecting-rod or link. As the crank revolves, it straightens the knuckle. The pressure transmitted to the ram is many times greater than that which could be produced through a single-acting direct-connected crank-operated type of machine. An additional advantage of the knuckle movement is the application of pressure at the end of the downward stroke. The position of the ram at the end of the stroke is controlled by a screw-actuated wedge. Different sizes of press are made, ranging in pressure capacity from 100 to 2000 tons per sq. in. of area of the part squeezed.

Details are given of the squeezing operations and the percentages of increase in production over that attained under former methods are summarized. The composition of the dies is specified, and the application of feeding mechanisms to such presses is described.

Grain structure of the coin-pressed forgings was studied exhaustively and photo-micrographs are exhibited. Three specific conclusions were reached and these are stated.

[1] Master mechanic, Hudson Motor Car Co., Detroit.

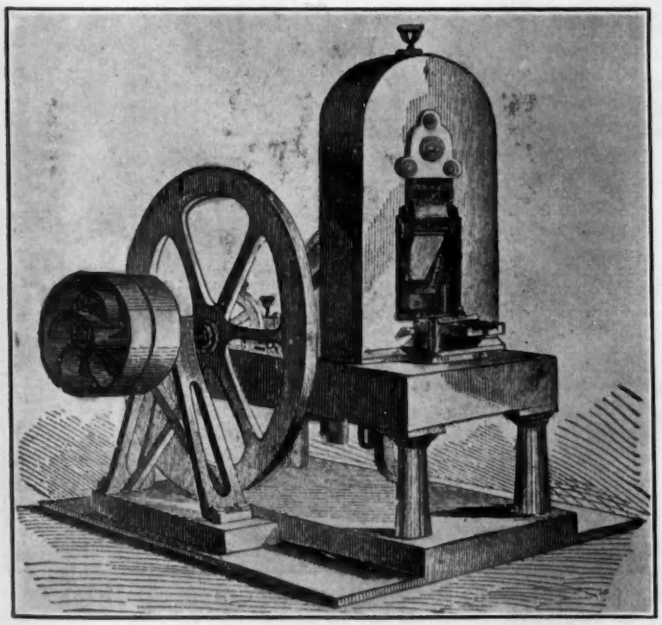


Fig. 1—The Original Coining-Press
In 1833 This Machine Was Invented by M. Thonnelier, of France. One of These Presses Was Included in the Original Installation of Equipment for the United States Mint in 1836

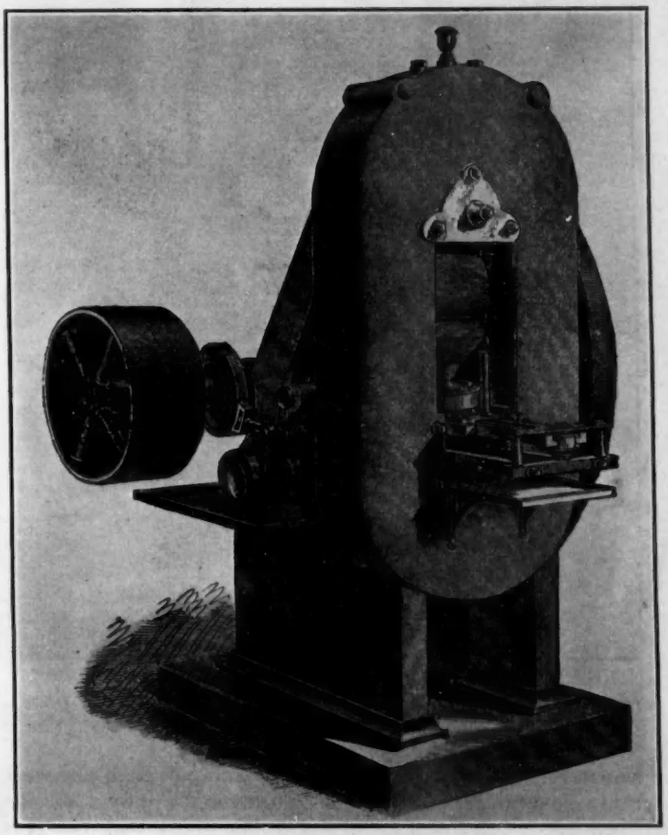


Fig. 2—The Coining Press of 1874
Gradual Improvements along Various Lines Were Made in the Press Illustrated in Fig. 1. The Short Stroke and a Lack of Rigidity Made Its Application Extremely Limited. In Spite of This Objection the Press, with Certain Modifications, Was Used Extensively for Other Operations than Embossing Coins, Medallions, Watch-Cases and Other Comparatively Flat Work

THE coining press is a machine capable of exerting tremendous pressure at its ram. It was used originally for the heavy service required in embossing coins. The first machine was invented in 1833 by M. Thonnelier, of France. In 1836 one was included in the original installation of equipment for the first United States Mint to emboss our Country's coins; it is shown in Fig. 1. Gradual improvements along various lines were made until, in 1874, we find a machine such as that shown in Fig. 2, which was the work of a well known American machine-tool builder at that time. This machine was the last word in coining equipment of that day. Its uses were extremely limited because of the short stroke and the lack of rigidity. The perfection of the later machine, with certain modifications, cause it to be used extensively for other operations than those of embossing coins, medallions, watch-cases and other com-

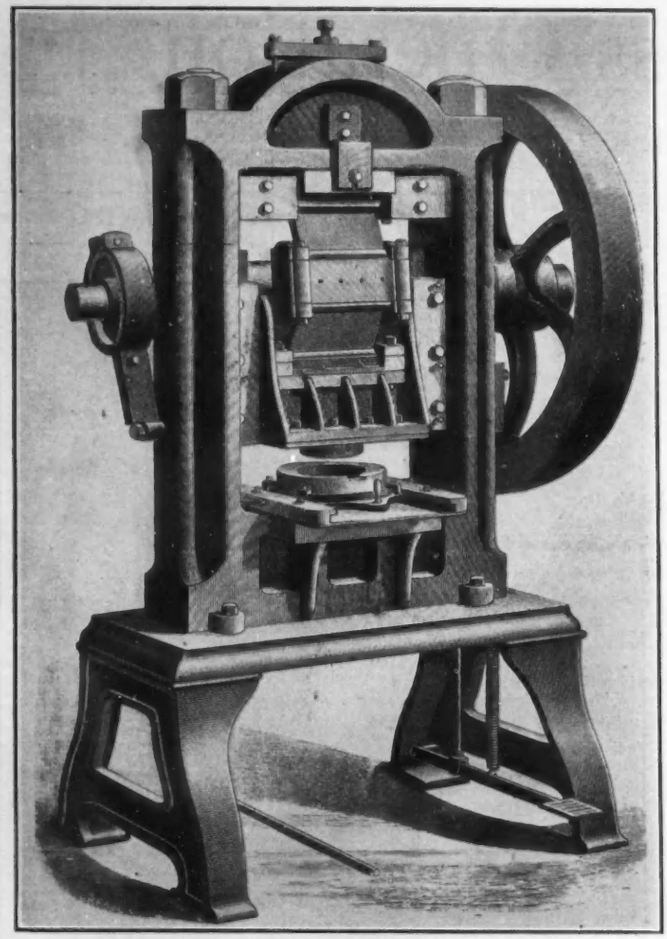


FIG. 3—A COINING PRESS BUILT IN 1883
This Press Is Said To Be the First Machine Having the Present Conventional Knuckle-Action. It Was the Forerunner of the Present Machine for Commercial Work

paratively flat work. The two principal changes were an increased die-space or shut-height and a longer stroke.

In 1883, we find the first coining-press that had the conventional knuckle-action; it is shown in Fig. 3. This was the forerunner of the present machine for commercial work. Further developments were made in 1897, but the toggles were placed underneath, as illustrated in Fig. 4. This design, however, became impractical when larger machines were built, because the increased distance from the floor to the dies made deep pits necessary for convenience in operation. Therefore, reversion to the previous construction became imperative. The result was a one-piece-frame construction, shown in Fig. 5, that was supplied in 100, 150, 250 and 400-ton capacities that weighed 7000, 9500, 13,000 and 18,000 lb. respectively. For convenience in manufacturing and transporting, presses with greater capacities were of the built-up type that consisted of a base, a frame and an upper housing; these were secured with four large tie-rods, as shown in Fig. 6. The latter classification includes machines having 800, 1000, 1200, 1500 and 2000-ton capacity. The 2000-ton press of the type shown in Fig. 7 weighs 235,000 lb. The modern machine has been renamed the "squeezing press" due to its varied adaptability to all classes of work within its range.

RUGGEDNESS OF CONSTRUCTION

These presses are very rugged in construction and have the appearance of a plain-type punch-press, except for the knuckle that operates the ram. This knuckle is coupled to a crank by means of a connecting-rod or link. As the crank revolves, it straightens the knuckle. The pressure transmitted to the ram is many times greater than that which could be produced through a single-acting direct-connected crank-operated type of machine. An additional advantage of the knuckle movement is the application of pressure at the end of the downward stroke. The position of the ram at the end of the stroke is controlled by a screw-actuated wedge. This is illustrated in Fig. 8, which shows the ram in both up and down positions.

SPEEDING-UP PRODUCTION

Increased schedules made equipment for milling or spot-facing forged arms and levers inadequate. This need was particularly manifested in brake and equalizer mechanisms. To meet the increased production, two ideas naturally presented themselves; first, to increase the number of the same machines used for the purpose, and, second, to change the method.

Data relating to coin-press methods were secured. Some of the heat-treated forgings, made from S. A. E. No. 1045 steel having a Brinell hardness of 197, were tested under an Olsen universal-testing machine. This test determined the load necessary to compress the part to the desired dimension. The average pressure required was 163,000 lb. per sq. in. of area. Other forgings, of S. A. E. No. 1025 steel having an average Brinell hardness of 137, required a load of 100,000 lb. per sq. in. of area. This gives some idea of the tremendous force necessary to coin-press parts when the affected area is of considerable extent.

It was concluded that one press could easily squeeze to size all of the parts and release the various machines on

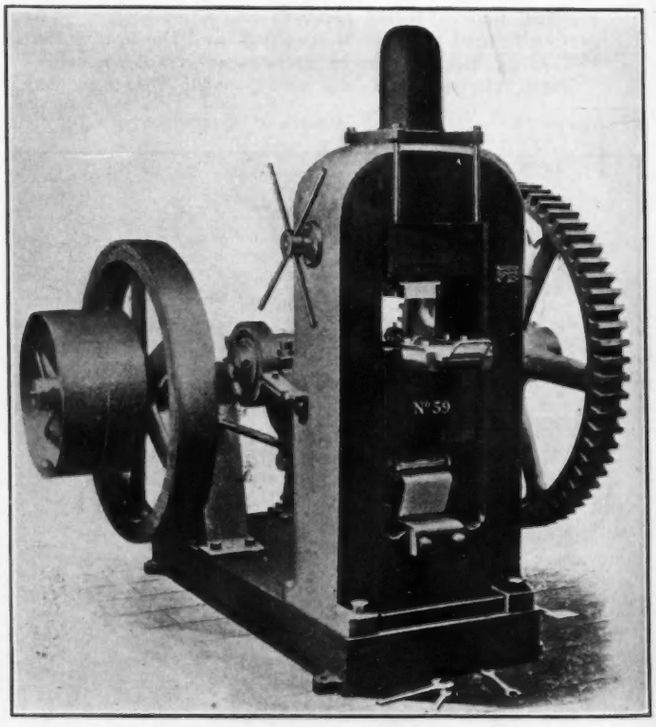


FIG. 4—AN 1897 TYPE OF PRESS
In This Press a Number of Developments Made Since 1883 Are Embodied, Including the Placing of the Toggles Underneath the Dies. When Larger Machines Were Constructed along This Line, the Increased Distance from the Floor to the Dies Made Deep Pits Necessary for Convenience in Operation. The Impracticability of This Design Rendered Reversion to the Earlier Construction Imperative

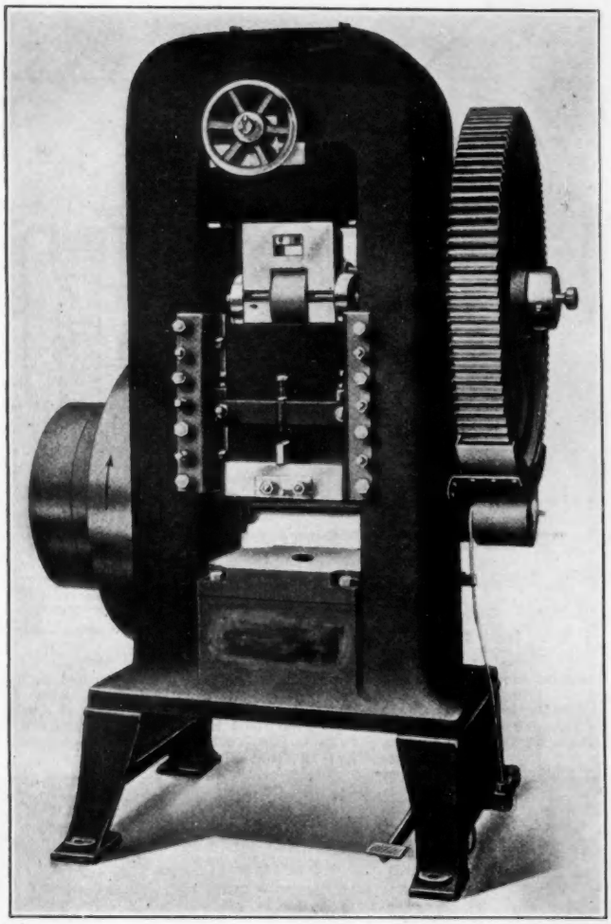


FIG. 5—THE ONE-PIECE-FRAME CONSTRUCTION OF 1919
The Objections to the Type of Press Illustrated in Fig. 4 Led to the Development of This Design. This Frame Construction Was Used in Presses Ranging from 100 to 400 Tons in Capacity and Weighing from 7000 to 18,000 lb.

hand for other work. The largest part had an area of 2 3/16 sq. in. on which a squeezing operation was necessary. A 400-ton coining-press, having the knuckle action previously explained, was installed. The finish allowance required for cutting on each surface was reduced from 1/16 to 1/32 in. This was found advisable under the squeezing method. With parts having two or more bosses of different thicknesses, steps were arranged on the dies as shown in Fig. 9; thereby all the bosses could be squeezed at one cycle of the press. It formerly had been necessary to perform a separate operation for each boss. With the new method one operation took the place of several operations. Very close limits were maintained, due to the fineness of the ram adjustment. Based on an efficiency of 75 per cent, a production thirteen times greater than that with the machining method was attained. The result was that one man and one machine replaced twelve machines and as many operators.

DIE MATERIALS

To determine the most suitable die materials, several sets of dies were made of different grades of cold-forging die-steel. The average run from the standard brands was limited to 6000 pieces. It, therefore, became necessary to resurface them for either or both of two causes: (*a*) fracturing of the working surfaces due to the extreme pressure to which they had been subjected, and (*b*) an impression of the part in the die at the point where pressure had been applied. To correct the difficulty, resort was had to a special steel of the analysis shown in Table 1. This composition was properly treated to a scleroscopic hardness of 90. The average output per grinding of the die surfaces rose to 40,000 pieces.

TABLE 1—ANALYSIS OF THE SPECIAL DIE-STEEL USED

	Per Cent
Silicon	0.050
Manganese	0.200 to 0.300
Carbon	0.670 to 0.800
Chromium	0.090
Vanadium	Trace
Sulphur	0.021
Phosphorus	0.010

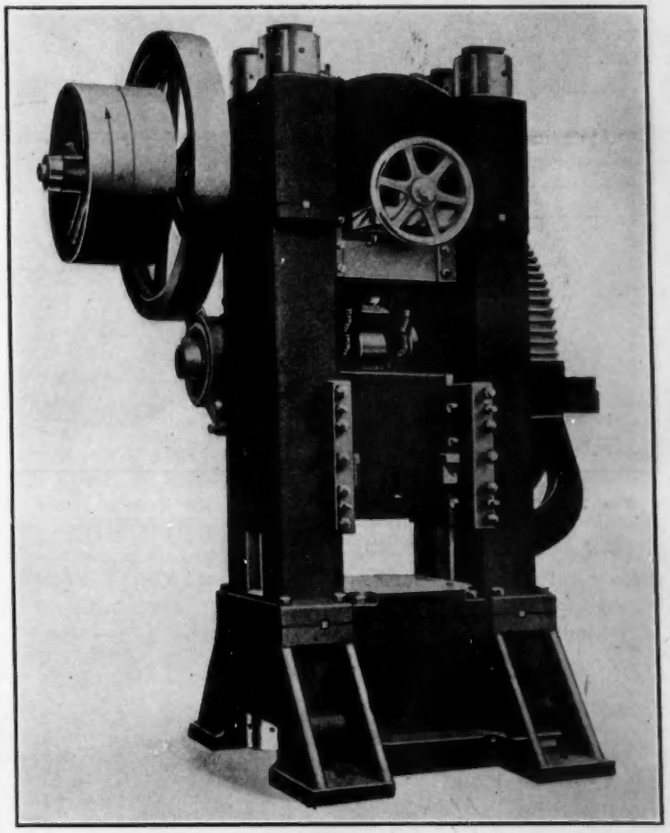


FIG. 6—THE BUILT-UP FRAME THAT MADE ITS APPEARANCE ABOUT 5 YEARS AGO
The Demand for Presses Capable of Exerting a Greater Pressure than the One-Piece-Frame Type Shown in Fig. 5 and Easy of Construction and Transportation Resulted in This Development. This Type of Press Consisted of a Base, a Frame and an Upper Housing, Fastened Together by Four Large Tie-Rods. The Range of These Presses Was from 600 to 1000 Tons' Pressure, the Largest Machine Weighing 65,000 Lb.

Experiments with this first group of parts opened the field because the savings were so great that the equipment could be amortized in less than 1 year. After a search to determine the requirements, three more 400-ton machines were purchased. These machines pressed all the parts shown in the group in Fig. 10, except the connecting-rods. Table 2 shows the percentage of increase in hourly production by squeezing.

SQUEEZING OF CONNECTING-RODS

After the four 400-ton machines had been in operation for a period of time with satisfactory results, it was decided that the next step would be the squeezing of the connecting-rods. The machining method required two

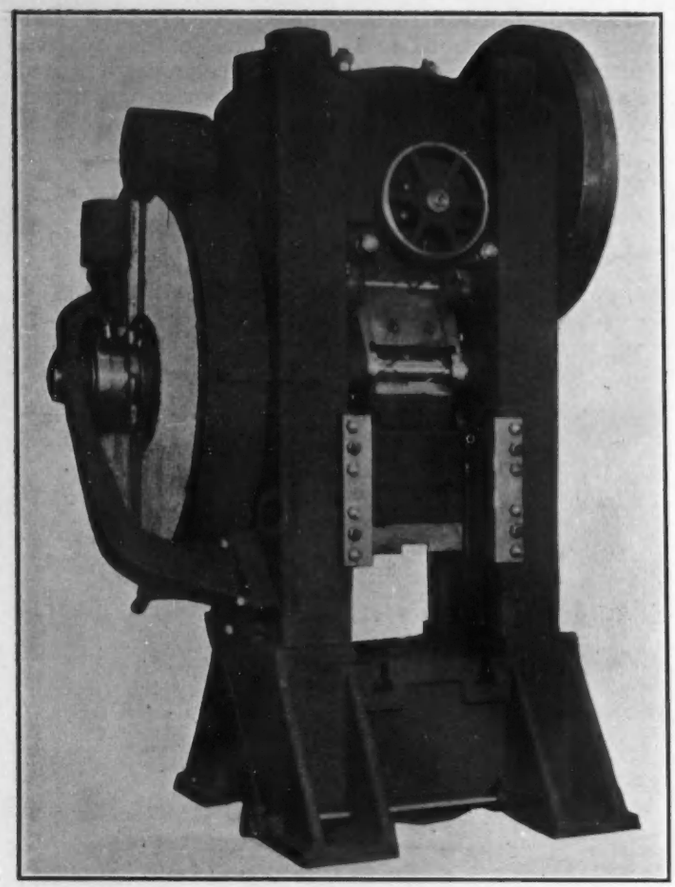


FIG. 7—A LATER DEVELOPMENT OF THE BUILT-UP TYPE OF PRESS
The Pressure Range of This Design Is from 800 to 2000 Tons, the Largest Machine Weighing 235,000 Lb.

heavy-duty vertical milling-machines of a well known rapid-index type, and an operator for each machine. The largest connecting-rod had a total area of 3-15/16 in.

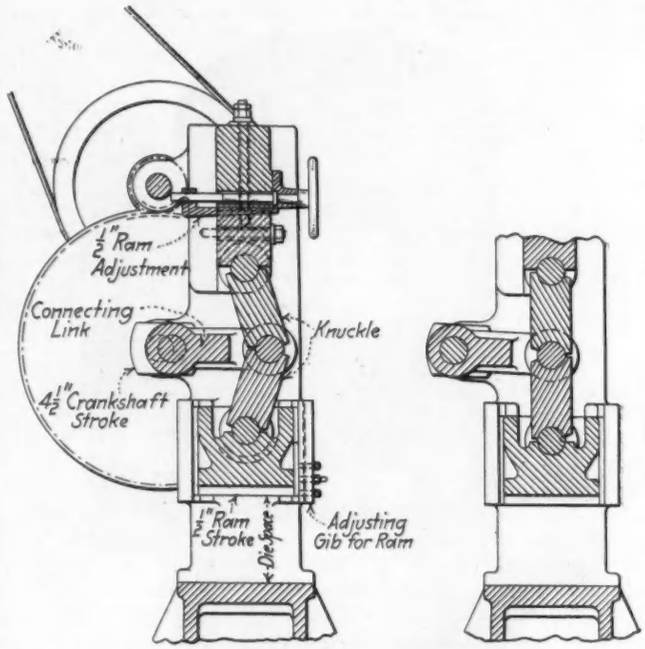


FIG. 8—CROSS-SECTION OF A KNUCKLE-TYPE PRESS
A Comparison of the View at the Left, Showing the Ram Up, and That at the Right, with the Ram Down, Readily Illustrates the Knuckle Action Which Possesses the Additional Advantage of Applying Pressure at the End of the Downward Stroke. The Position of the Ram at the End of the Stroke Is Controlled by a Screw-Actuated Wedge That Is Also Shown

TABLE 2—INCREASE OF PRODUCTION DUE TO SQUEEZING

Group Number	Part Name	Percentage of Increase
5	Brake Lever, Single	1,043
6	Equalizer Shaft, Arm	960
11	Brake Lever, Double	780
13	Internal Brake Lever	928
15, 16, 17, 18	Foot Pedals	480

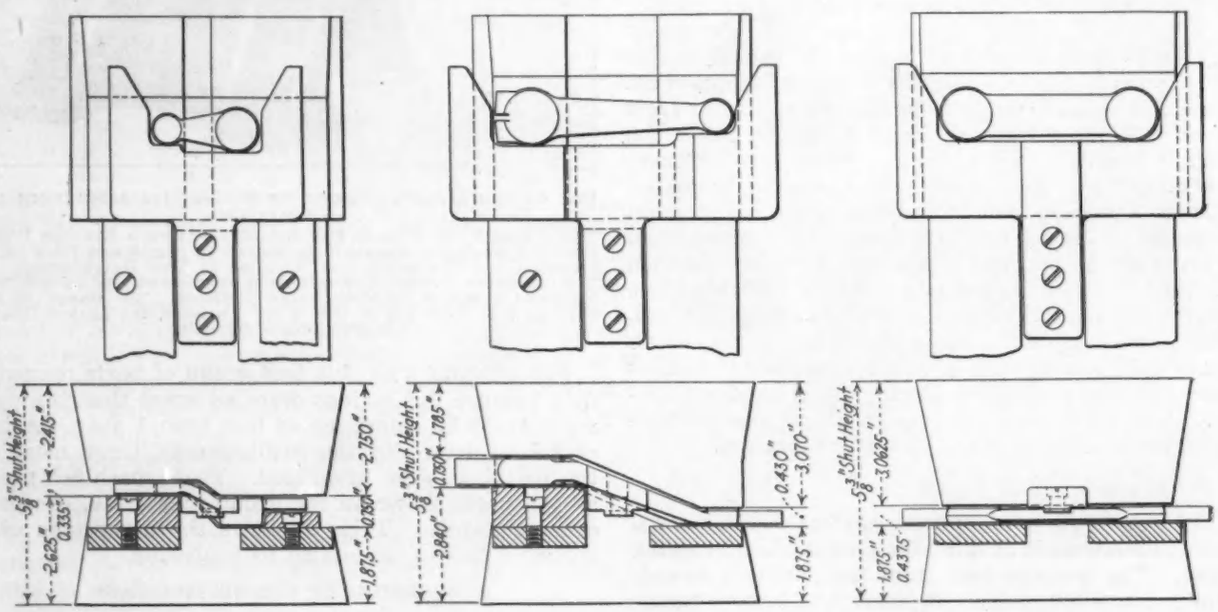


FIG. 9—FEEDING FINGERS AND DIES USED ON A 400-TON COINING-PRESS WITH KNUCKLE ACTION EMPLOYED IN THE PRODUCTION OF AUTOMOBILE PARTS
The Three Upper Views Show the Feeding Fingers. The Lower Set of Views Illustrates the Manner in Which Steps Were Arranged on the Dies So That with Parts Having Two or More Bosses of Different Thicknesses, All of the Bosses Could Be Squeezed at One Cycle of the Press, Instead of Performing a Separate Operation for Each Boss. The Feeding Finger (Above) and the Die (Below) in Each Group Are for the Same Part

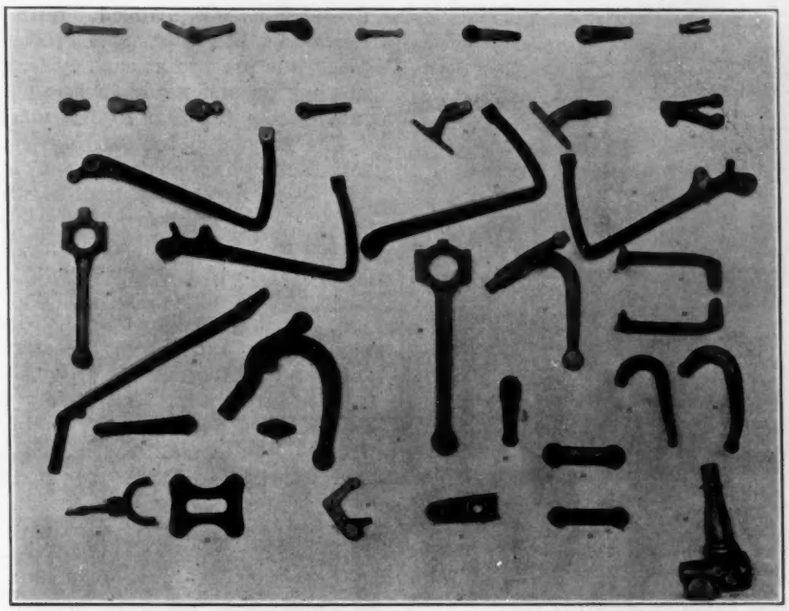


FIG. 10—AUTOMOBILE PARTS PRODUCED WITH A 400-TON COINING-PRESS

Some Idea of the Versatility of This Machine Can Be Gathered from an Inspection of This Illustration. Parts Produced in This Way Include Pedals and Levers of Various Kinds, Head-Lamp Brackets, Steering and Fan-Support Arms, Spring-Shackles and Axle Spindles. The Increased Hourly Production Made Possible by the Use of a Press Ranged from 480 Per Cent for Brake and Clutch Pedals to 1043 Per Cent for a Brake Lever

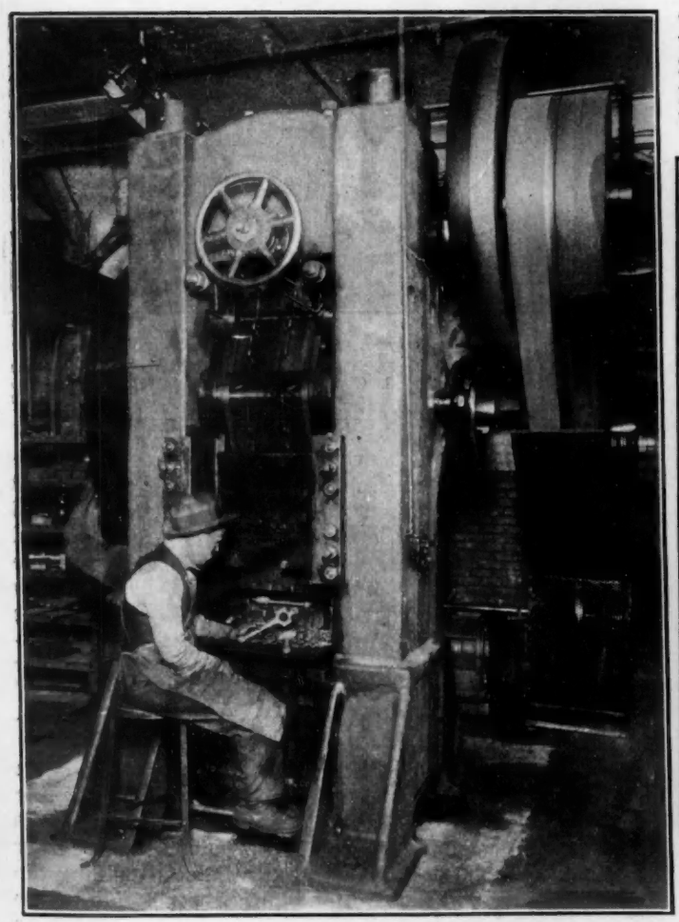


FIG. 11—AN 800-TON PRESS PRODUCING CONNECTING-RODS

With Hand-Feeding the Production of This Part Was Increased 251 Per Cent

of metal to displace. An 800-ton press, shown in Fig. 11, was selected for this work. It increased the production 251 per cent, when one operator was hand-feeding the press. After a feeding mechanism had been installed on the press, as shown in Fig. 12, to eliminate any possible

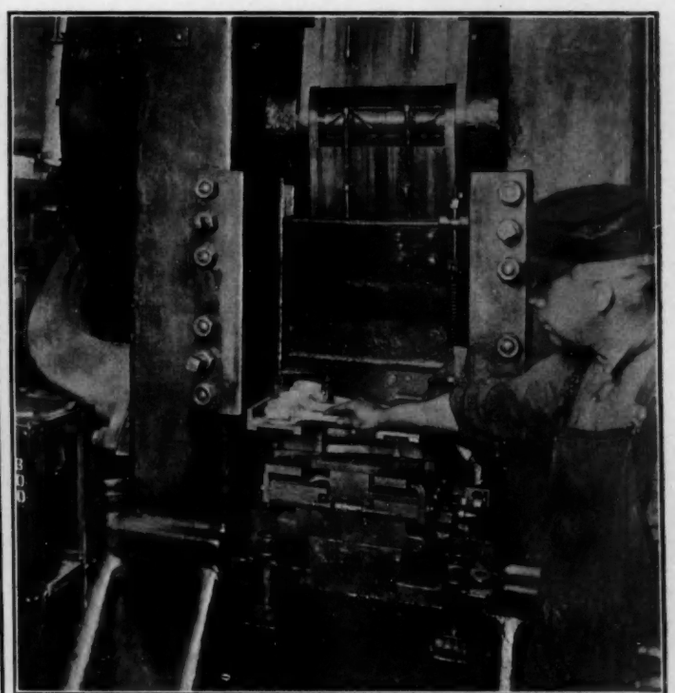


FIG. 12—OPERATOR LOADING THE FEEDING MECHANISM INSTALLED ON THE PRESS SHOWN IN FIG. 11

After the Installation of This Feeding Mechanism To Eliminate Any Possible Chance of Injury to the Operator, the Production Was Increased 147 Per Cent over the Hand-Feeding Method of Fig. 11. This Resulted in a Total Increase of 370 Per Cent over the Machining Method That Required Two Vertical-Spindle Milling-Machines of the Rapid-Index Type with an Operator for Each Machine

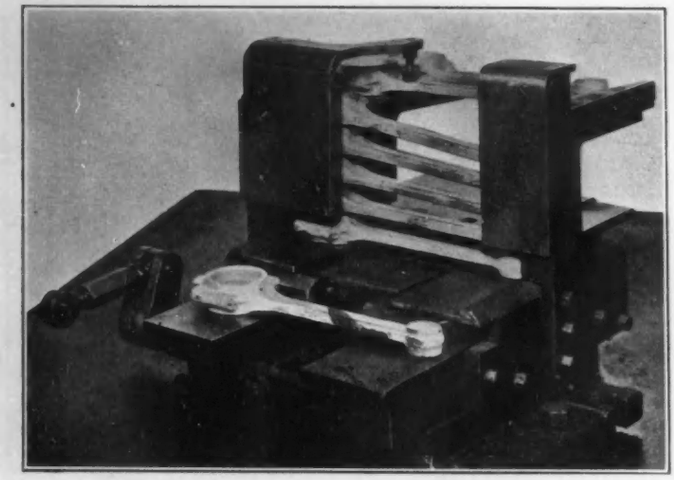


FIG. 13—THE MECHANISM USED TO FEED CONNECTING-RODS TO THE PRESS

This Mechanism, Which Was Attached in Front of the Bolster Plate, Consisted of a Channel in Which the Rods Were Stacked and a Reciprocating Slide That Operated To Feed a Forging to the Die at Each Stroke of the Ram. With Hand-Feeding Only One Stroke in a Possible Five Was Utilized; the Incorporation of the Magazine Enables a Piece To Be Pressed at Each Cycle

chance of injury to the operator, the production was again increased 147 per cent. This final result was 370 per cent greater than the production attained by milling. The product still was held to the 0.004-in. tolerance.

The feeding mechanism mentioned was attached to the front of the bolster plate. It consisted of a channel, shown in Fig. 13, in which the rods were stacked and a reciprocating slide was operated in a manner to feed a forging on to the die at each stroke of the ram. When the stock was fed by hand, only one stroke of a possible five strokes was utilized. With the incorporation of the magazine, the press was in continuous operation and a piece was pressed at each cycle. Fig. 14 shows a forging in position and ready to be squeezed. Fig. 15 is a view taken from the rear of the machine.

The magazine for feeding the connecting-rods proved satisfactory as a production and as a safety factor. Therefore, a feed mechanism was designed to take care of all the parts shown in Fig. 10, except those that required to be held in position while squeezing at a local point. With this arrangement, the work is fed to the die by a slide equipped with detachable fingers. These fingers are designed to meet the requirements of the individual part that is being pressed. Fig. 9 shows the dies and the feed fingers.

To assure the greatest safety to the operator and keep him at a safe distance from the ram, a pull-type feed with a 12-in. stroke was installed. The driving member was attached to the rear of the ram. It operated the slide through a crank movement fitted between the sides of the die and the housings of the machine. The front was thus left clear except for the feed slide. To guard against stock jamming, a safety spring was incorporated in this driving member. The recommended speed of the press is 32 cycles per min. At this rate, however, the speed of the feeding device was so great that impetus imparted to the work forced many pieces through beyond the die. Therefore, the work was made to pass under a flat spring acting as a drag. This permitted handling the smallest parts while the press ran continuously at the desired speed.

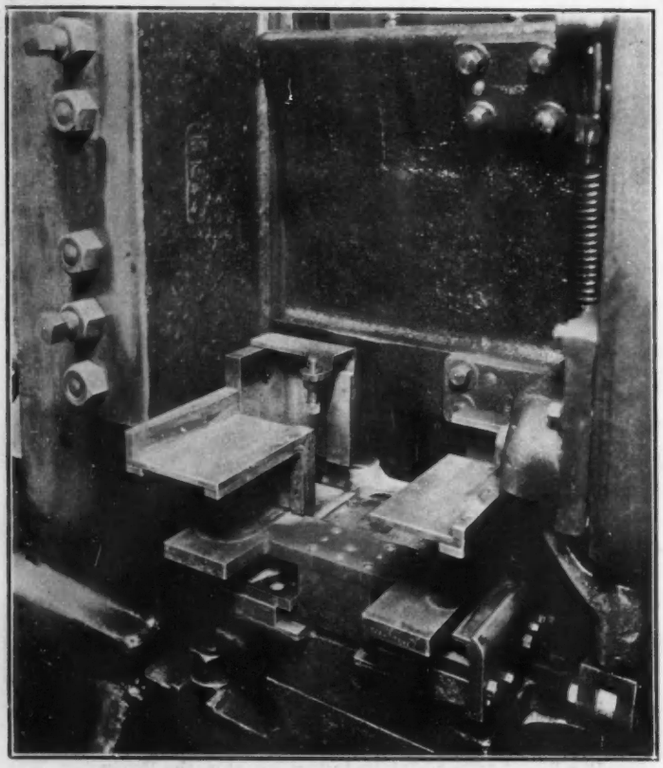


FIG. 14—A FORGING READY TO BE SQUEEZED

This View Was Taken from the Front of the Press with the Ram and the Dies Ready To Descend and Form a Connecting-Rod

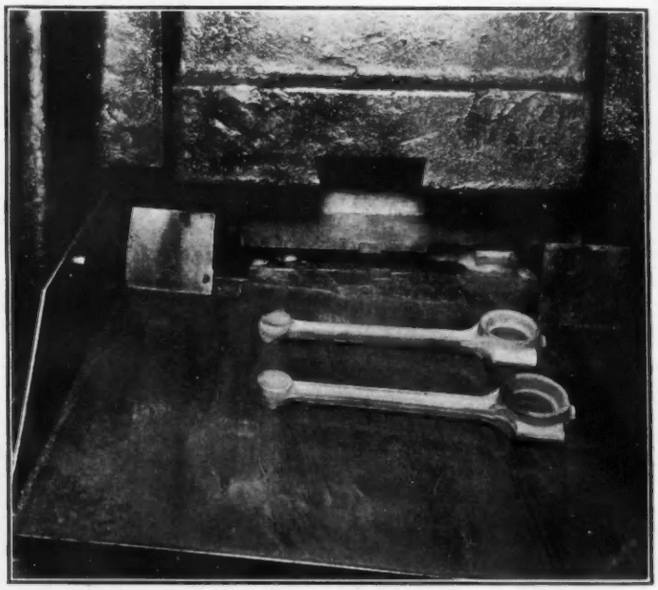


FIG. 15—VIEW OF THE REAR OF THE COINING PRESS

In This Illustration a Forging Can Be Seen in Position between the Dies, While Two Finished Connecting-Rods Are Shown in the Foreground. The Inserts in the Die Blocks Are Necessary To Keep the I-Beam Section of the Rod from Becoming Kinked

Fig. 16 gives views of a machine on which this device was used. That at the left shows an operator loading work, while the slide is in the back position and the dies are squeezing a piece that was fed previously. The drag spring in front of the upper die can be seen holding the piece. The central illustration shows the position of the slide when injecting stock, and the view at the right was taken at the rear of the machine as the work came through. It also shows where the driving member with

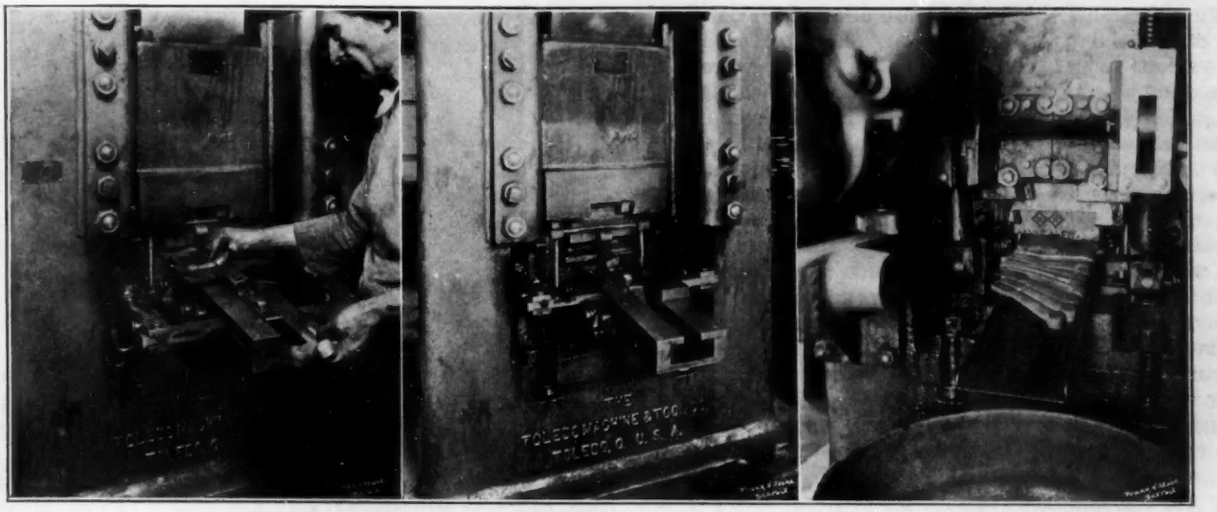


FIG. 16—THREE VIEWS OF A FEED MECHANISM FOR SMALL PARTS

The View at the Left Shows the Slide in the Loading Position. The Central View Shows the Position of the Slide when Injecting Stock; the Drag-Spring in Front of the Upper Die Should Be Noticed in This Illustration. At the Right the Work as It Comes through the Machine Can Be Seen; Attention Is Directed Particularly to the Driving Member with the Safety Spring Attached to the Ram. This Mechanism Permits the Smallest Parts To Be Handled with the Press Running Continuously at the Desired Speed

its safety spring is attached to the ram. Table 3 gives a comparison of the increases made by both the manual and the mechanical feeds.

TABLE 3—COMPARISONS OF INCREASED PRODUCTION

Group Number	Part Name	Percentage of Increase Over the Machining Method: Manual Feed	Mechanical Feed
1	Accelerator Lever	387	583
4	Accelerator Lever	430	537
5	Brake Lever	1,042	1,864
11	Brake Lever	780	944
28	Clutch Yoke	358	894
32	Fan-Supporting Arm	624	774

GRAIN STRUCTURE OF COIN-PRESSED FORGINGS

Believing that it would be of general interest to know what happens to the grain structure when a forging is coin-pressed, an investigation of this was made. For this purpose a connecting-rod was chosen. This part is made from S.A.E. 1045 steel. Before coin-pressing it was warm-water quenched from 1475 deg. fahr. and then drawn to 1100 deg. fahr. This produced a Brinell hardness of from 187 to 217.

Several sections across coin-pressed areas were examined. It was impossible to note distortion of the grains, at 100 diameters magnification. Because of the fine-grain structure of the heat-treated connecting-rod, any change that had taken place would have been difficult to discern. For this reason, several rods were heated at a high tem-

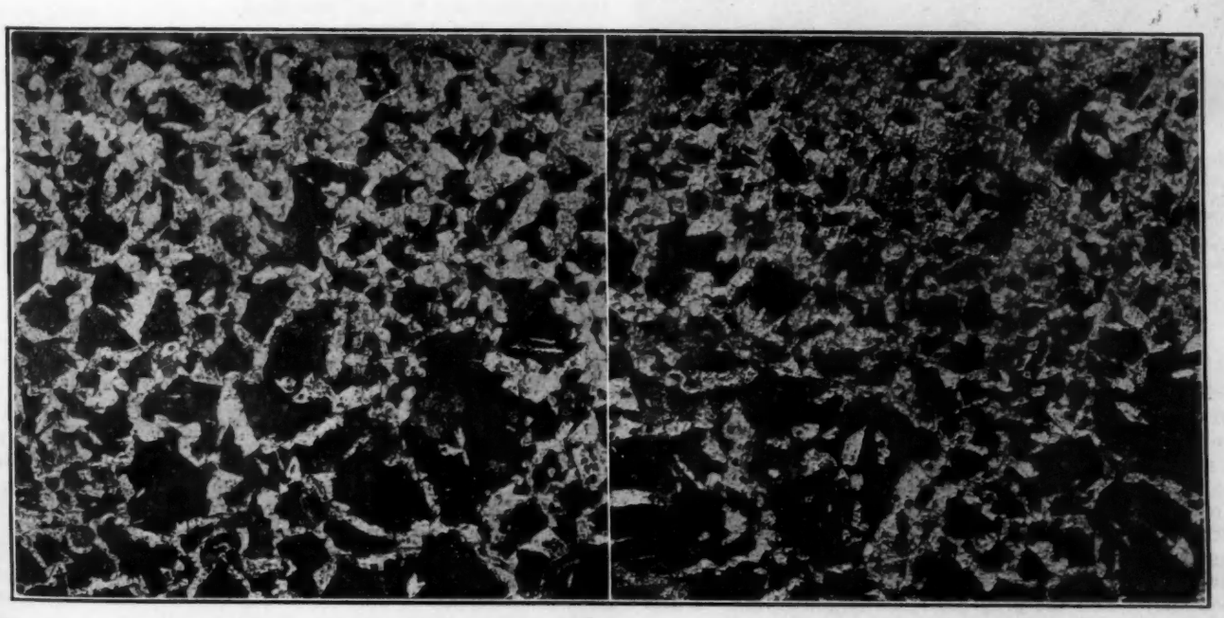


FIG. 17—WHAT HAPPENS TO THE GRAIN STRUCTURE OF A PIECE THAT IS SQUEEZED IN A COINING PRESS

The View at the Left Is the Original Section and That at the Right the Compressed Section. No Grain-Distortion as a Result of Compression in the Press Is Noticeable. The Magnification in Each Case Is 100 Diameters

perature for a long time, and were allowed to cool slowly. This caused the grains to grow large and to separate into the various constituents. Some of them were coin-pressed and sections were examined. No change was noticeable. This seems to indicate that the compression of the section is uniform throughout the total volume.

To substantiate this conclusion, one of the annealed connecting-rods was coin-pressed across one-half the area of the piston-pin boss. This gave three different conditions on a cross-section through the boss. One section, which was the original structure not compressed, is shown at the left of Fig. 17; a second section in which the structure was compressed is reproduced at the right. The latter should show a decided grain-distortion if the structure had changed. It was prepared and examined under the microscope, and no difference between the original structure and the structure which had undergone compression was revealed. Photo-micrographs at a magnification of 100 diameters, showing the sections at the surface before and after compression, were made. It was apparent that the grain structures were identical.

To show what would happen if the distortion occurred

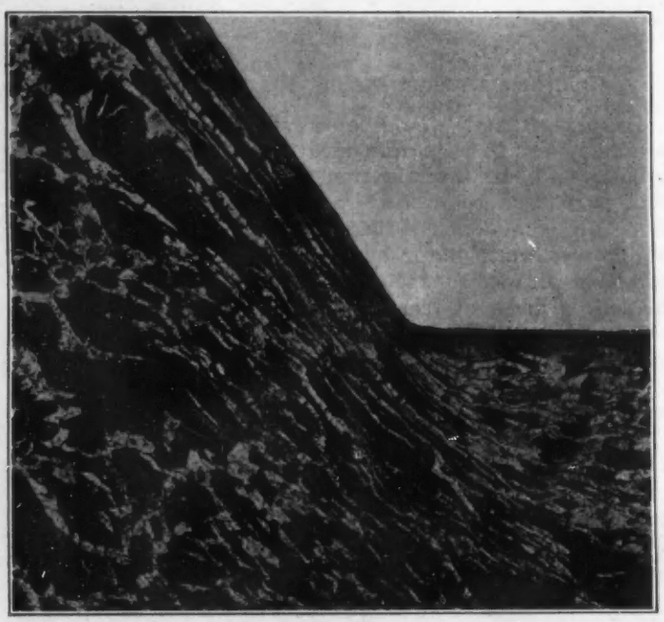


FIG. 18—PHOTO-MICROGRAPH OF THE INTERMEDIATE SECTION AT THE LINE OF CONTACT

In This Instance Distortion of the Grain Structure Occurred At or Near the Surface, the Grains Being Flattened and Elongated Out of All Proportion to Their Original Dimensions, as Can Be Seen by Comparing This Illustration with the Two Views of Fig. 17, the Magnification in All Three Illustrations Being the Same, 100 Diameters

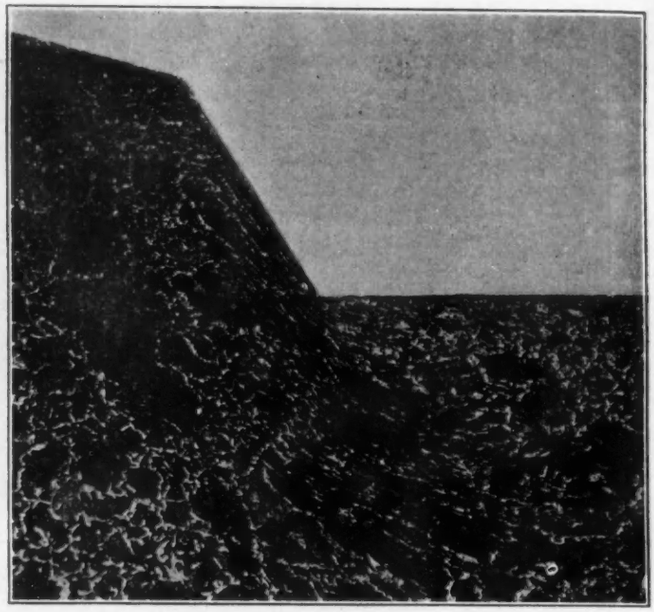


FIG. 19—ANOTHER PHOTO-MICROGRAPH OF THE INTERMEDIATE SECTION AT THE LINE OF CONTACT

This Illustration Covers the Same Area as Fig. 18 and Shows That the Distortion Occurred only in the Grains Adjacent to the Line of Contact. The Magnification in This Instance Was 35 Diameters

at or near the surface, a third photo-micrograph was taken at the line of contact. The effect was readily seen; it is illustrated in Fig. 18. The grains were flattened and elongated out of all proportion to the original dimensions. A fourth photo-micrograph was taken of this same area at a magnification of 35 diameters, to give a better idea of the effect of the distortion. It can be seen from an inspection of Fig. 19 that the distortion occurred only in the grains adjacent to the line of contact. This showed conclusively that the coin-pressing operation did not affect the material adjacent to the surface. It was a uniform compression throughout the entire volume of the part coin-pressed. From the foregoing, the conclusions reached are that

(1) A coining press will squeeze parts to size with the same degree of accuracy as is accomplished by the removal of surplus stock through cutting operations

(2) There is absolutely no difference in the molecular constituency of the parts after they are squeezed

(3) Under quantity-production conditions, the average number of parts prepared per hour by a coining press is 900 per cent greater than is secured with usual machining methods

GAGE-STEEL

THE Gage-Steel Committee of the Bureau of Standards is an informal committee, organized in January, 1922, to study gage-steels and their heat-treatment with a view to increasing the permanency of dimensions and resistance to wear of gages used in interchangeable manufacture. The committee is composed of steel-makers, gage-makers and gage-users, all of whom are vitally interested in improving the quality of gages. A commendable spirit of cooperation has been shown and the progress made is gratifying. Much work needs to be done before the many problems involved can be said to have been satisfactorily solved.

A series of steels and a program of heat-treatments have been selected which seem most likely to lead to success, and the Committee is now investigating the permanency in wearing qualities resulting from the steels and the heat-treatments selected. Three types of laboratory wear-test have been conducted at the Bureau of Standards. While the results obtained are not conclusive, they are reasonably consistent. The laboratory wear-tests are now being supplemented by service tests under the conditions that actually exist in factories.

The representatives of the Society on the Committee are J. M. Watson, of the Hupp Motor Car Corporation, and C. N. Dawe, of the Studebaker Corporation of America.

Utilization and Prevention of Waste

By C. B. Auel[1]

Production Meeting Paper

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

SAVINGS that might be effected by the utilization of waste material and by the prevention of unnecessary waste, though frequently discussed, do not seem to be fully appreciated. Manufacturers are too prone to start with the assumption that a certain amount of waste is unavoidable and consequently have treated the subject in a perfunctory manner, their efforts being largely centered on items of design, workmanship and material. Even less scrutiny is sometimes given to the so-called expense materials. But improvement in the reduction of waste is as surely possible as is improvement in the products. A full recognition of the importance of salvaging would mean the opening of a new field of engineering, that of the consulting salvage engineer.

The customary assumption that no one is so well qualified to determine the waste in design or manufacturing as the actual designer or builder should be true but sometimes is the reverse. The question is whether the best disposition is being made of the unavoidable waste in design, workmanship and material, as well as in the expense materials. If it is possible to sell the waste from one's own plant for more than the customary scrap value it should also be possible to use some of the waste products of other concerns, instead of new materials, in one's own plant.

The duties of a salvaging engineer would be the studying of a plant for the purpose of (*a*) preventing or minimizing waste items, (*b*) reclaiming as much of the unavoidable waste as possible, (*c*) disposing of the waste to the best advantage, and (*d*) applying the wastes of other manufacturers to one's own products.

In the Westinghouse Company three committees devote their attention to this subject: The standards division of the engineering department, the standards committee, and the disposition department; and, indirectly, also, the materials and process division of the engineering department.

The activities of the standards division deal largely with the standardization of most of the production and many of the expense materials; the materials and process division with the preparation of purchasing and process specifications; the standards committee, with the standardization of complex matters; and the disposition department, not only with the salvaging of waste but with the reduction and elimination of waste of all kinds. It gives the greatest share of its attention to inactive stocks, raw, semi-finished and finished, with a view to preventing their becoming obsolete. Under this department also come the clean-up inventories and the general inspection.

Many instances are cited in which waste from one department or plant has been utilized in another.

THE possibilities in the prevention and the utilization of waste have not yet been generally realized by industry, though these subjects have formed the theme of many articles in the press for several years. Statements, of course, are easy to make yet sometimes hard to prove, but in this case the proof is easy, if proof is needed, for the indictment is already on record, having been made officially by the Committee on Elimination of Waste in Industry of the Federated American Engineering Societies and published under the caption, "Waste in Industry."

Manufacturers have been too prone to start with the assumption that some waste in manufacture is unavoidable and, consequently, have treated the matter in a perfunctory manner, being more or less satisfied to scrutinize the items of defective design, workmanship and material and, if these appear to be within reason, to make the necessary allowances in factory overhead, and to rest content thereafter. Even less than scrutiny is too frequently given the so-called expense materials. This is a gross error of judgment, for improvement is possible almost as surely in waste prevention and utilization as it is in any regular line of manufacturing; in fact, I am fully convinced that the time is not far distant when such work will be recognized as of sufficient importance to call for a new branch of engineering talent, the salvaging engineer. In the larger manufacturing plants, this talent will probably be developed from among their own forces; but, in the smaller concerns, it is not inconceivable that outside help, a consulting engineer, may be called on for assistance.

The hasty assumption must not be made that this idea is far fetched and should be dismissed accordingly, with the brief statement that no one is so well qualified to determine whether undue waste of material in design or manufacturing exists as is the actual designer and builder. This should, of course, be true; but sometimes the very reverse has proved to be the case.

Assuming, however, that it is so, consideration must still be given to whether the best disposition is being made of the unavoidable wastes of design, workmanship and material, as well as those of expense materials, the items thus classed being those which are necessary to the manufacture of any regular product but do not actually enter into it. If it be granted that these wastes might perhaps be disposed of at some other than the customary scrap-value, provided systematic search were made for customers and customers could actually be found for one's own waste products, the assumption would seem to be fair that the waste products of other concerns might be used instead of new materials, to some extent at least, in one's own concern.

The Salvaging Engineer

Among the duties of the salvaging engineer, whether belonging to the regular staff of a company or called in as a consultant, would be the studying of a plant for the purpose of (*a*) preventing or minimizing all waste items, (*b*) reclaiming as much of the unavoidable waste as possible, (*c*) disposing of the waste to the best advantage, and (*d*) applying the waste of other manufacturers to one's own products.

For many years past, our company has paid particular attention to these matters and, no doubt, a very brief description of some of our methods, as well as a statement of a few of our accomplishments, will be of interest.

[1] Manager of employe's service department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

All departments in the works naturally assist in the prevention of waste, some to a greater degree than others, as would be expected; but, in what follows, attention will be concentrated principally on three departments, whose duties more particularly concern both the prevention and the utilization of waste. These are the standards division of the engineering department, the standards committee, and the disposition department, although another division of the engineering department, the materials and process division, also indirectly enters into the work.

The standards division of the engineering department, as its name in some measure implies, has to do with the standardization, within certain limits, of most of the production and a number of the expense materials. When this work was originally taken in hand, all production items of the more commonly used kinds were tabulated from existing drawings and similar sources, and, after undergoing the most careful study, were arranged in lists of what were felt to be the proper and the adequate sizes and kinds to cover our needs. Many off-sizes were encountered and these were omitted; and a number of new ones were included, when they were necessary to fill in the gaps. These lists were then distributed to other divisions of the engineering, as well as of the manufacturing departments. When thus issued, they became standard and it was compulsory thereafter to adhere to them in selecting materials. Tabulations of expense materials followed in much the same manner. Our standards were not made retroactive, for it was recognized that an almost prohibitive amount of expense and time would be involved in the changing of drawings and records and opposition would naturally be created on all sides. Furthermore, the filling of repeat-orders on products, built previously to the issuing of the standards, would on occasion have made it imperative to continue to use items that had not been listed. As is to be expected in work of this kind, changes in these standards have been found advisable from time to time; but these changes have become fewer as the years have passed, until now standardization is largely an accomplished fact.

Unless one has actually undertaken such a task, the savings that can be effected, especially in a large works with diversified lines of products, are hardly believable. Not only are savings possible, because of the reduced kinds and sizes of stocks carried and the simplification of records, but the liability is lessened of dead stocks' being left on hand when designs have been superseded or improvements made, for the parts are more nearly common to all sizes. Lower prices moreover can frequently be obtained through the purchasing of larger quantities of each kind, consequent upon the fewer sizes.

The sizes and kinds of several representative items that it was deemed necessary to carry in stock before standardization was effected and those found to be necessary afterward are given in Table 1.

TABLE 1—NUMBER OF SIZES AND KINDS OF STOCK NECESSARY TO BE CARRIED BEFORE AND AFTER STANDARDIZATION

Item	*Before Standardization*	*After Standardization*
Steel Tubing	35	20
Brass Tubing	206	90
Copper Tubing	78	37
Slate	336	70
Lock-Washers	45	39
Hammers	36	30
Files	180	30

To keep from retrograding, all requests for production materials must pass through the standards division, whose work has just been described, en route to the purchasing department, so that opportunity may be afforded for scrutinizing them. If a new item appears, inquiry is at once made of the department desiring it, to determine whether it is essential to depart from the standards that have already been established.

Whenever changes in design are contemplated, a complete study of the stocks on hand, or purchased but not delivered, is made to determine when such changes can best be put into effect. This study covers machine-tools, equipment and floor-space, as well as the question of supply parts; in fact, endeavor is put forth to see that no point is overlooked, and the probable advantages are carefully weighed against the possible disadvantages. Experience over a period of years has enabled us finally to develop a course of procedure that seems to meet our needs, for, in several instances, it has allowed a rather extensive series of changes to be made in a complete line of apparatus, with a write-off of only a small fraction of 1 per cent.

Materials and Process Engineering Department

Reference has been made to the materials and process engineering department as having to do to some extent, though indirectly, with the prevention of waste; perhaps it would be well to touch briefly upon the work of this department before proceeding further. Materials are purchased largely according to specifications and these are prepared by this department. In general arrangement, the form recommended by the American Society of Testing Materials is followed.

When preparing a purchasing specification, advantage is taken of materials already in the market, and also of the experience with them of various other concerns who are frequently consulted. The data thus obtained are combined with our own ideas or experience, if any, to form a preliminary specification. This specification is then submitted to suppliers of material of this description and their comments and criticisms which are almost invariably given freely are obtained. Thus fortified, a purchasing specification is finally prepared and issued. Suppliers are invited to submit samples. If the tests of the samples prove satisfactory, the materials are placed on an approved list, to which the purchasing department is expected to confine itself to subsequent purchases. Revisions in these purchasing specifications are made from time to time so that, in the main, they may be said to be uptodate.

If specifications are necessary to cover the raw materials entering into one's product, their equivalent would seem to be equally necessary for the finished product and its parts. Manufacturing specifications are likewise prepared, therefore, by the materials and process engineering department. Consequently, we have developed a line of what are termed process specifications, which set forth each detail of a manufacturing process, including the items, quantities, operations, times, degrees, finishes, sizes, and the like. Like the purchasing specifications, they are revised as improvements in the products are made. The advantages of these process specifications over any other method of supervision are so obvious as almost to make comment on them unnecessary. Suffice it to say, that, by these means, there is always a standard way of doing a thing, with no change as a result of changing personnel, no repetition of earlier errors, or use of less accurate methods; there is therefore the minimum of defective work from these causes.

The Standards Committee

The standards committee is the second of the three main departments having to do with waste and waste prevention. Its work parallels in a manner that of the standards division, except that the items handled by it are usually more complex. The make-up of this committee is unique, consisting as it does of only two permanent members, the chairman and the secretary. These two are constantly on the lookout for new subjects that are suitable for consideration as standards and, when such subjects are found, a subcommittee is appointed to work with the chairman, and instructions are issued on the work to be done. In order to facilitate matters, a representative of the standards division sits in with each subcommittee so that, when data are needed, he can arrange for procuring them with the least amount of delay. From six to ten of these subcommittees are always at work. Their chairmen form the other members of the standards committee. When any subcommittee is ready to make a report, a meeting of the chairmen of all the outstanding subcommittees is called by the permanent chairman to consider it. When a report has been accepted by this main committee of chairmen, and further approved by the management, the subcommittee that made the report is dissolved. The members of these subcommittees do not allow their regular duties to be neglected, and for this reason the reports sometimes require a greater length of time to complete than they would otherwise, but, aside from this, no drawbacks to the scheme have been found.

The subjects considered by the subcommittees are very diversified, although not intruding into the field of design to a larger extent that do those of the standards division. Aside from standardizing certain production and expense materials and methods, attention at times is also given to small tools and to shop and office equipment. A glance at the following list will indicate how wide a range is covered.

1. Punched Circular Washers
2. Tap-Drills
3. Eye-Bolts, Allowable Stresses
4. Bearing Babbitt
5. Furniture Standards
6. Handle Grips
7. Ferrules
8. Thumb and Wing Nuts
9. Storeroom Fixtures
10. Anchor Holes in Bearings
11. Marble, Slate and Soapstone Bases
12. Trucks, Barrels and Wheel Tote-Boxes
13. Counterbores and Facing Tools
14. Pulley Sizes
15. Anchor Plates and Foundation Bolts
16. Rigid Couplings
17. Finish Allowances on Bolts and Nuts
18. Steels for Tool-Room Use
19. Shaft Allowances for Pulley Fits
20. Keys
21. Punched Nuts versus Machined Nuts
22. Spot-Welding
23. Springs, Reduction of Sizes
24. Hammers
25. Tubing, Brass and Copper
26. Springs, Material
27. Slot-Files, Machinists'
28. Cleats
29. Oil-Rings
30. Welding, Illustrations and Definitions
31. Bed-Plate Design and Method of Lifting
32. Passes for Employes
33. Crane Chains and Slings
34. Bearing Allowances
35. National Screw-Threads
36. Protective Treatment for Materials to be Soldered
37. Paper Forms
38. Lumber
39. Belting
40. Fiber and Paper Containers
41. Storing Employes' Clothing

The Disposition Department

The disposition department, which is the third of the three main departments mentioned as having to do with waste and waste prevention, embraces more than the salvaging of waste materials, for it endeavors as well to reduce or to eliminate waste of all kinds. It will be seen therefore that its staff must of necessity be thoroughly familiar with its own plant, including the materials used, the methods of manufacture, the products and the personnel and, at the same time, have a wide knowledge of the uses to which materials may be put that appear as waste in the plant. If this knowledge is supplemented by a familiarity with the methods of other plants, such knowledge will on occasion prove of value in enabling waste material to be purchased and substituted for good raw material.

The disposition department gives the larger share of its attention to inactive stocks, raw, semi-finished and finished. These are regularly reviewed, the idea being to endeavor to prevent their becoming obsolete. This is accomplished in various ways, advantage being taken of any existing channels that seem to offer opportunities for disposal, though the department is empowered, if necessary, to create new ones.

All inactive stocks, and these embrace not only those showing no movement, but those showing insufficient movement over a given period, are listed and at the same time depreciated and passed on to the disposition department for treatment that will tend to put them back into the active class or at least prevent the necessity for more drastic action. If, at the end of a year, the disposition department has been unable to get results, the stocks are further depreciated, the disposition department meanwhile continuing its efforts to move them. If, at the end of another year, they are still inactive, they are transferred to the obsolete class, are more heavily depreciated and, within the following 6 months, if movement fails, are disposed of.

Disposition of Inactive Materials

In disposing of inactive materials, endeavor is made first to apply them "at home," for in this way the loss is likely to be least. If not possible to apply "as is," some simple modification may be all that is necessary, like the redrawing of a copper strap to allow it to be used. Or the engineering department may be called upon for help and permission may be obtained to substitute one material for another, say where the cross-section continues unaltered but the dimensions differ.

Failing application at home, all surplus raw materials, hardware, cutting-tools and pipe-fittings are bulletined, as shown in Table 2, and distributed to the various works, as well as to commission agents at reduced prices.

Work-in-progress also comes under the scrutiny of the disposition department through the medium of quarterly "cleanup" inventories, at which time "held" orders pass in review. All such orders must be lifted out of the work-in-progress account and placed elsewhere, as it is not considered either good business or fair to those in charge of manufacture to make the account bear a burden of this kind.

TABLE 2—TYPICAL LIST OF SURPLUS RAW MATERIALS TO BE DISTRIBUTED TO OTHER DEPARTMENTS OR SOLD

Material	Amount, Lb.	Size	Works	Code
COPPER, BARE SOFT				
1 Strap	405	0.625x0.3125 in.	N.	4–22
2 Strap	15	0.375x0.5 in.	N.	4–22
3 Strap	489	0.625x2 in.	N.	4–22
4 Strap	400	0.875x1 in.	N.	4–22
COPPER, SOFT TINNED				
5 Strap	161	0.0159x1 in.	E.P.	4–22
COPPER, BRUSH HARD				
6 Ribbon or Strap	10	0.0031x½ in.	N.	4–22
COPPER, BARE HARD				
7 Bar	273	0.051x⅜ in. x 120 in. long.	M.	4–23
8 Bar	741	1/16x⅛ in.	M.	4–23
9 Bar	8000	1/16x½ in. x 120 in. long.	M.	4–23
10 Bar	1055	1/16x⅞ in. x 120 in. long.	M.	4–23
11 Bar	996	5/64x½ in.	M.	4–23
12 Bar	228	1/16x⅝ in.	M.	4–23
13 Bar	256	1/16x⅝ in. x 120 in. long.	M.	4–23
14 Bar	441	1/16x1¼ in.	E.P.	4–23
15 Bar	1368	0.063x0.875 in.	E.P.	4–22
16 Bar	1500	0.063x1.25 in.	E.P.	4–22
17 Bar	480	0.080x3 11/16 in.	M.	4–23
18 Bar	800	3/16x⅝ in. x 120 in. long.	M.	4–23
19 Bar	580	3/16x½ in.	M.	4–23

During the quarterly clean-up, inspections are made of all employes' cupboards and drawers, and any tools in excess of a normal supply are returned to the tool rooms, thus keeping small-tool investment within bounds.

The disposition department does not confine its activities to the functions already mentioned; for, if their investigations in salvaging lead them to believe that waste may be prevented anywhere, they do not hesitate to follow the matter back to its source, even to stock control. The field of this department, however, does not include the work of inspection, such as the examination of raw and semi-finished materials coming into the works, or of the regular product in course of manufacture, or even the disposition of routine scrap, such as turnings, borings, filings, and the like, all of which can be handled by the inspection department. Within the functions of the department, however, are the general inspection of all departments and yards for the purpose of seeing whether the regulations for the avoidance of waste that have been established are being observed; when the department does not have charge, the work is specifically delegated to some other department.

The Search for Waste

These inspections are more important than they seem to be at first glance, and should hardly be passed by without a few words of additional explanation. Aside from the more evident yet often overlooked items that must be watched for, such as electric lights or gas fires left burning needlessly, water or steam-pipes or air-hose leaking, motors allowed to run unnecessarily, and so on, other items not so apparent but equally important, so far as waste is concerned, are numerous, and careful attention to them will result in wastes being avoided. Among these may be mentioned motors too large or too small for the work, caused by rearrangement of shop tools, high-priced oils used for cutting and machine-tool lubricants when low-priced oils would serve the purpose, turpentine instead of cheaper substitutes used for thinning paint, mixing of metal wastes instead of keeping them separate, solid high-speed-steel tools instead of tools with high-speed-steel nose and carbon-steel shank, cotton waste for near-white wiping rags, checking of gages and meters, and the like.

Checks are made at intervals on the power supply both for voltage and for speed, as a moderate drop in voltage, say 10 per cent, will lower the factory illumination 30 per cent, and any reduction in the speed of the generators, if they are of the alternating-current type, as is generally the case, will correspondingly affect the speed of the driving-motors throughout the factory.

A great deal could be said on the subject of the storing, boxing and shipping of stocks, for these items should not be omitted in a study of waste prevention. Though handicapped at times for space, we endeavor nevertheless to observe certain precautions that experience has taught us to observe. Boxed material is fully marked on the outside so as to be readily identified, and this marking is given a coat of shellac to keep it from being obliterated. Materials in fiber or paper containers are raised several inches from the floor to avoid the effects of moisture, many readily oxidizable items are given a protective coating, and much cast iron is paint-dipped before being shipped from the foundries. Sufficient space is allowed between the aisles and all piles are reversed at intervals to avoid retaining the older stock.

Spontaneous Combustion

Sheet material, such as oiled duck, is never piled in layers more than 1 in. thick without being separated by pieces of wood to reduce the risk of spontaneous combustion. Oily waste is always stored in metal containers. Bar stock that is piled vertically to conserve space is painted either across the ends or with a full-length stripe so that one kind can be distinguished from the other. Sheet-steel material is similarly painted.

Wooden boxes, serving as containers for incoming material, are made over into smaller sizes and our own apparatus is shipped in them. Smaller pieces that cannot be worked up and other burnable waste are fed under boilers and an entire building is heated by them. In one of the plants, the wood that is too small for boxes and too good to burn is made into small bundles, one end of each bundle being dipped into melted resin and the bundles then sold for fire-wood. Of course, this last operation is done through a concession and not by us directly.

Apparatus is sometimes shipped, mounted on skids, instead of being boxed or crated. Open cars are used for certain shipments for which closed cars were formerly thought necessary.

Misprint salt bags are used as containers for small items like screw-machine work. They are cheap and can be used many times. Burlap bags, if not used as containers for parts, are cut into strips and used for wrapping coils, and the like. At one time, paper bags were used to enclose arc lamps, keeping the mechanism entirely free from dust.

Scrap Department

A scrap department has of course been installed. This is fitted with all the necessary appliances that go to make a complete outfit of its kind. Scrap is first sent to be inspected and classified before being further distributed. Every consignment to this department must be accompanied by full information so that, if necessary, the department forwarding it may be communicated with and called to task if customary procedure has been violated. One class of scrap, however, that does not reach the

scrap department is bulk iron and steel filings, turnings, and borings from the heavy machining departments. These accumulate so rapidly that they are placed in large containers and unloaded by cranes every day or two onto freight cars that are brought directly into the departments.

Several years ago, a careful study was made of the various kinds of non-ferrous scrap, the quantities of each kind, the amounts received from their sale, the cost of reclaiming, and the like, with the result that a reduction plant was installed. We now not only reclaim almost all our non-ferrous metals, but buy from our subsidiary plants and affiliated interests as well.

Since we use drawn copper in very large quantities, it is only logical that we should install a copper mill, where much of our reclaimed pig copper is drawn out into bar and strap stock. This mill has also largely eliminated inactive sizes of copper bars and, to a less extent, of wire.

Sawdust, mixed with soda, is used as a fire-extinguisher for oil fires, and is used for drying purposes in the plating department as well as for packing; this is also true to some extent of shavings. Waste paper is largely sorted, baled and sold, although it may be shredded and used for packing purposes. Soiled wiping-rags, formerly reclaimed by us, are now sent by one of our plants to a laundry; the washing is paid for at so much per pound for the rags returned; when reclaimed by ourselves, care was necessary to avoid fires, and it was this feature that compelled us to abandon reclaiming them ourselves. Used sugar-bags serve admirably as fine wiping-cloths, being superior to and cheaper than cheese-cloth or canton flannel.

Scrap Sheet-Iron Baled

Scrap sheet-iron of the thinner sizes is sold after having been baled by machine, a higher price being thus obtained than otherwise. Oily or worn belting is reclaimed by immersion in gasoline and is then made over into belting or into hand leathers, washers, and the like, the smallest pieces being sold to manufacturers of boot heels, carburizing materials, and the like. One of our plants prefers to send its belting to a company that will reclaim as much of it as possible and sell it back at a heavy discount from the list price.

Used files are purchased from junk-dealers. They can usually be resharpened twice and then recut. Tests show that they give results equal and in many cases superior to those with new files, and at a considerably reduced cost. Cutting-tools of high-speed steel, when too short for further use, are drawn out to the next smaller size and continued in use. Empty carbide-cans are mounted on feet and used as waste containers.

Welding is employed regularly both in production and on repairs; when defects can be corrected on material on which labor has been performed and which would otherwise be a loss, the saving is sometimes considerable. When one of our works had a steel foundry connected with it, the electric arc was largely used to cut off sink heads and risers. Cutting oils are reclaimed.

Nuts, bolts, screws, rivets and washers become mixed from various causes and are regularly resorted. Large magnifying glasses on milling-machines engaged in certain small work have eliminated all defectives. Paper clips that find their way to the baling-press with the waste paper are easily gathered up from the floor by means of a small magnet. Hand soap is laid away and allowed to harden for a time, as it then lasts longer than when freshly used; it has been found to be more economical when cut into small pieces.

Interdepartmental envelopes are ruled across the front and left unsealed; they may thus be used several times before being finally discarded. Short lengths of copper wire and strap, steel and iron, paper and bar, and the like, are electrically welded. Nickel anodes, and other material, such as angle or channel-iron, are welded with the oxy-acetylene torch. An automatic cut-off valve is used, which shuts off the gas, leaving only a pilot-light burning. Hydrogen welding is employed for reclaiming lead battery-lugs, and the like.

And so the list of savings might be continued to considerable length, especially if in it were included items of less general interest and having to do more particularly with our own industry, such as the patching of slate, or the making of copper-tube connectors from the ends of mill-length tubing. It is believed, however, that enough has been shown to demonstrate, if any demonstration is needed, that the reclamation and prevention of waste are like electricity, as yet in their infancy.

FEDERAL-AID ROAD-FUNDS

PROVISION for Federal aid for the fiscal year 1925, which began on July 1, authorized the Secretary of Agriculture to apportion to the States the $75,000,000 authorized by the Post-Office Appropriation Act of 1922. Thus Federal-aid road-work will not be interrupted. The apportionment is made to the States on the same basis as in preceding years, except that Hawaii for the first time is granted a share. Since 1916, a total of $540,000,000 has been made available by acts of Congress. The bureau of public roads of the United States Department of Agriculture that administers the funds, reports: completed, 32,099 miles; under construction, 17,000 miles; approved for construction, 2518 miles; and $33,106,126 available for new projects.

Practically all of the old funds and the entire amount of the new funds have been, or will be, expended on the Federal-aid highway-system of the United States. This system, consisting of approximately 170,000 miles of road, has been designated by the States and approved by the Federal Government. It was estimated that at the beginning of the present year 60,000 miles of the system have been surfaced and about 8700 miles graded; leaving 110,000 to be surfaced. Some of this work has been done by the States independently of Federal aid. To surface the remaining 110,000 miles by 1934 will require an annual program of 11,000 miles. The new legislation carries an appropriation of $6,000,000 for national forest roads and trails. In the apportionment of Federal-aid funds, the amounts received by the different States vary from $365,624.87 to $4,410,169.76.

Development in Naval Aeronautics

By Com. H. C. Richardson,[1] U. S. N.

Aeronautic Meeting Paper *Illustrated with* Photographs and Drawings

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

PRINCIPAL developments along the lines of the HS, H-16 and F-5-L types of airplane, which were used during the war for convoy work, submarine patrol and scouting, are represented by present types PN-7, equipped with Wright T-2 engines, and PN-8, having Wright T-3 engines, a metal hull and metal tail-surfaces. Brief statements about their construction and performance are made and the subject of metal floats for airplanes is discussed. "Training," scouting and other types of airplane are mentioned, and outlines given of their characteristics and performance.

Launching seaplanes from a catapult is described, some details of the development of the apparatus being given, and reference is made to a late development in which the catapult is actuated by the explosion of a powder charge instead of being operated by compressed air. Aircraft engine, propeller and accessory developments, seagoing aircraft-carriers and lighter-than-air craft are treated also, and numerous illustrations are presented.

NAVAL Aeronautics, which covers the use of Naval aircraft with and for the United States Navy, presents a number of problems to be solved that are peculiar to the employment of aircraft over the water, whether such craft be operated from ships or from shore stations.

Operations from shore stations are pretty generally understood. They were well developed during the war in convoy work, submarine patrol and scouting. For these purposes, the well known HS, H-16 and F-5-L types were used, the last of these being illustrated in Fig. 1. Because of defective protection against rear attack from the air, the HS machines were used only when contact from enemy airplanes was unlikely, but the H-16 and F-5-L machines were used generally and were equipped with bombs, bomb-sights, guns and radio.

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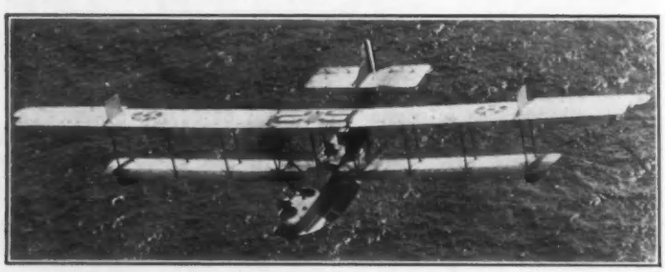

Fig. 1—The F-5-L Seaplane
This Machine Has a Wing Area of 1397 Sq. Ft. and a Ceiling of 5000 Ft. It Is Equipped with Two 360-Hp. Engines That Are Capable of Producing a Maximum Speed of 90 M.P.H. and a Minimum of 51.7

The principal developments along this line have been the PN-7, shown in Fig. 2, and PN-8. The PN-7 type was equipped with the Wright T-2 engines. The PN-8 type was equipped with the Wright T-3 engines, the hull and the tail surfaces being made of metal. The PN-7 made a 105-day cruise to the West Indies during the winter of 1923-1924; it returned without change of engines, the only replacement being one rocker-arm bearing. The time in the air was 150 hr. The improvement in performance over that of the F-5-L is shown in Fig. 3. Though designed for a 14,000-lb. load, a load of 17,000 lb. actually has been taken off readily. With a view to improving this design still further, a metal hull has been built at the Naval Aircraft Factory. Fig. 4 shows this hull under construction. The hull is 500 lb. lighter than the wooden hull; and a metal PN-8 design of the tail surfaces has resulted in a saving of an additional 70 lb. Also, the water soakage is eliminated. Soakage is a factor of no mean importance, for it has reached a figure in excess of 10 per cent of the normal flying-load, after 4 months of operation, in cases where the seaplanes have been maintained without facilities for beaching them and drying them out. Fig. 5 shows the framing of the PN-8 type.

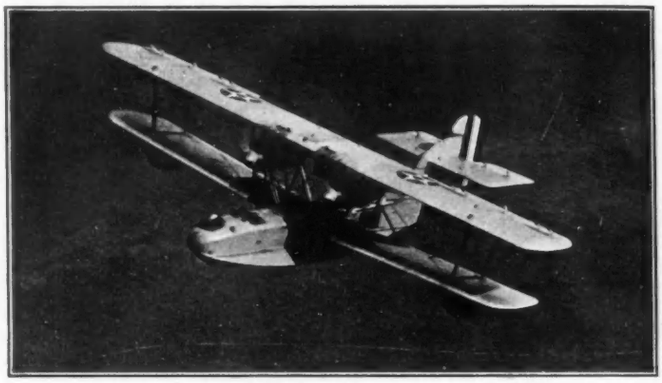

Fig. 2—The PN-7 Seaplane
One of These Machines Made a 105-Day Cruise to the West Indies and Return without Changing Engines, the Only Replacement Being One Rocker-Arm Bearing. The Actual Time in the Air on This Cruise Was 150 Hr. The Wing Area Is 1220 Sq. Ft. The Wright T-3 Engines Composing the Powerplant Have a Total Rating of 1050 Hp. The Maximum Speed Is 113 M.P.H. and the Minimum, 53.5. The Airplane Has a Ceiling of 10,500 Ft.

Metal Floats

Metal construction of floats is attractive from the standpoints of weight saving and the elimination of soakage. However, so little has been done along these lines that it is practically a new art. The metal con-

structions of Dornier, Zeppelin and Junkers have been studied, as well as that employed in the Fokker types. Stout has done important pioneer work in airplane construction, as well as Glenn Martin and Curtiss. Curtiss has done some float-work and so have Glenn Martin and Brewster, but the most ambitious work in floats has been done by Aeromarine. Brewster has built metal floats for the TS and the EM planes, both being excellent in workmanship. Curtiss and Glenn Martin have built floats of metal which have been satisfactory.

Naval development of metal floats dates back to 1913, when a composite metal-skin and frame float of the Curtiss type was built, but the form of the hull was experimental and was not satisfactory. As early as 1911, Alger built metal floats for a Wright airplane, but they had to be covered with linen to make them watertight.

Recent developments preceding the construction of the PN-8 hull comprised the construction of a series of N-9 metal floats at the Naval Aircraft Factory. In these designs the form was maintained constant, but the details of construction and the thickness of metal used were varied to determine to what extent weight could be saved and, incidentally, to determine the simplest forms of construction. Simple construction is very important; first, because the actual cost is at present fairly high, primarily due to the lack of stock forms and the necessity of fabricating small quantities of the forms necessary; and second, due to the large amount of riveting required, frequently in locations where access is difficult.

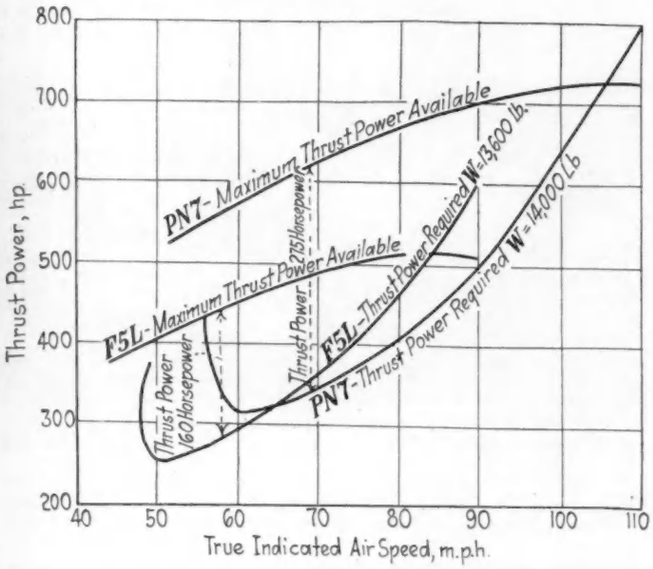

FIG. 3—CHART SHOWING THE IMPROVEMENT IN THE PERFORMANCE OF THE PN-7 SEAPLANE OVER THAT OF THE F-5-L TYPE

With Its Full Load of 13,600 Lb. the F-5-L Airplane Had an Initial Rate of Climb of 390 Ft. per Min., While the PN-7 Was Designed for a Climbing Rate of 650 Ft. per Min. with a Load of 14,000 Lb. In Actual Tests the Plane Has Taken-Off Readily with a Load of 17,000 Lb.

The questions of maintenance and repairs, and of corrosion, are important. To the designer, however, the prime difficulty is to bring concentrated loads into the structure and distribute them to the bottom plating; conversely, to provide against the highly localized loads on the bottom at different stages of get-away, from at-rest to take-off and from landing to at-rest conditions. These conditions are so varied by the state of the wind and the sea and by the operation of the airplane as to be almost infinite in range. The important conditions to be met are (*a*) at-rest afloat, (*b*) in full flight, particularly where the hull is utilized as a fuselage, (*c*) at get-away or landing on the step and (*d*) in a "stall" landing, in which the tail of the float makes first contact.

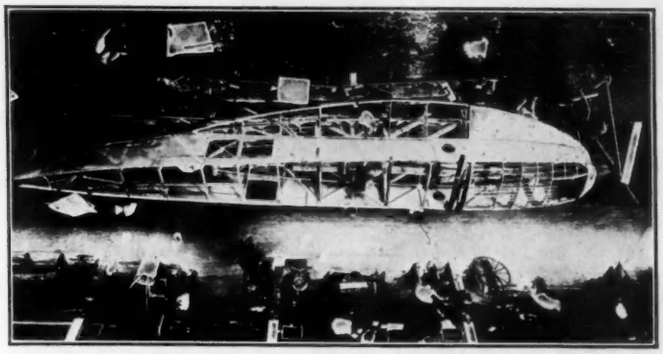

FIG. 4—THE PN-8 METAL HULL UNDER CONSTRUCTION

This Hull was Developed as an Improvement over the Wooden Construction Formerly in Use. A Saving of 500 Lb. Has Been Effected By the Substitution of Metal for Wood and a Metal Tail-Surface Has Resulted in an Additional Saving of 70 Lb. Water Soakage, Which Has Reached a Figure in Excess of 10 Per Cent of the Normal Flying Load after 4 Months of Operation, Has Been Eliminated

The N-9 float-design No. 7, weighing 227 lb. as compared with 293 lb. for a wooden hull, dry, for float No. 7, and 340 lb. for a wooden hull, including soakage, is a successful form; this is shown in Fig. 6. The concentration points for the strut loads are indicated at *A*, *B* and *C*. It will be seen readily how these loads are transmitted to the bottom framing through bulkheads and girders and thence to the bottom plating.

All these floats have been built of duralumin. Some difficulty has been experienced due to corrosion in salt water, but this has been due principally to the failure of complete application of protective coatings. This difficulty has been practically overcome, but access for inspection and maintenance are essential.

MODEL-BASIN TRIALS

The form of floats is always controlled by model-basin trials. Steady improvement continues in this detail. The N-9, R-6, NC and DT floats, and the floats of the Schneider Cup Racers of 1923 were so developed, and the floats used on the Douglas World Cruisers were derived from the DT floats. Thus, the work of the model basin deserves the credit of producing floats which made

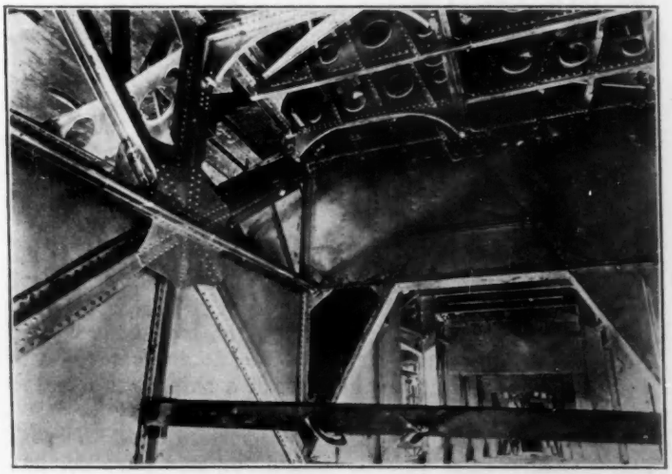

FIG. 5—FRAMING OF THE PN-8 HULL

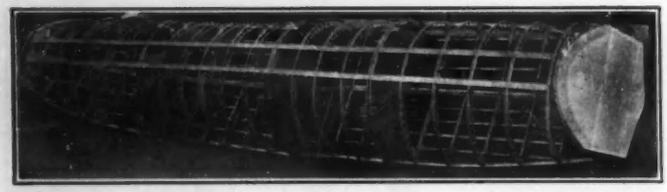

FIG. 6—ONE OF THE SERIES OF DESIGNS FOR THE N-9 METAL FLOATS
This Particular Design of Float Weighs 227 Lb., as Compared with 293 Lb. for Dry Wooden Hull and 340 Lb. for Wooden Hull Including Soakage. The Concentration Points for the Strut Loads Are Indicated at *A*, *B* and *C*. These Loads Are Transmitted to the Bottom Framing through Girders and Bulkheads and Thence to the Bottom Plating

the first trans-Atlantic flight and the Round-the-World flight possible.

The reduced weight of metal floats improves the maneuverability and, naturally, results in improved performances of the airplanes; in particular, it is noted that the ailerons are livelier due to the reduced moment of inertia about the longitudinal axis of the airplane.

"TRAINING" TYPES OF AIRPLANE

As to the "training" airplanes, the old N-9 illustrated in Fig. 7 has stood up well and its ruggedness has saved lives in many crashes. Recently, after careful trials of several designs, the Boeing NB-1, shown in Fig. 8, has been adopted for the future training program of the Navy. This is a tractor biplane, convertible for use on land or sea, and is equipped for gunnery training. It is fitted with a Lawrance air-cooled engine of 200 hp. This airplane has the Boeing electric-welded tubular fuselage; of course, it is a dual-controlled machine. Unlike in the Army, primary training is given on seaplanes but, as land airplanes are used from the carriers and may be used from catapults on other ships, land training is also part of the course. In addition to the primary training,

FIG. 7—THE N-9 TRAINING SEAPLANE
The Ruggedness of This Plane Has Saved Lives in Many Crashes. This Airplane Has a Wing Area of 488 Sq. Ft. and a Ceiling of 8850 Ft. The Powerplant Is a Single 150-Hp. Engine That Is Capable of Developing a Maximum Speed of 80 M.P.H. and a Minimum of 40.7

acrobatics, combat, bombing, gunnery, torpedo plane, navigation and radio training are included in the course. For advanced training the F-5-L, HS, DT, UO and VE-7 airplanes are used.

SCOUTING AND OTHER TYPES

Scouting at sea is an important phase of the work under development. It requires endurance, protective armament and radio. For the present it is accomplished by the F-5-L, VE-7 and UO types, the last being shown in Fig. 9. This machine, with the floats removed and equipped for landing on the deck of a ship, is illustrated in Fig. 10.

Spotting of gun-fire is very important, and the MO and NO airplanes were developed for this purpose, but the newest type is the amphibian VO-3, drawings of which are presented in Fig. 11. The MO is the first serious attempt of the Navy at all-metal framework; the construction details are excellent. Unfortunately, a serious tail-vibration has developed which to date resists being remedied. At present DH, VE-7 and UO machines are filling gaps in the program.

The amphibian will be able to operate from catapults on battleships and cruisers, or from the deck of carriers. It can also operate from the surface of the water or on land, and can land on the deck of a carrier. To a certain extent, this type can also perform the duties of scouting, in addition to spotting.

Bombing planes appeared first in the forms of HS, H-16 and F-5-L. The latest development in this line is the CS, shown in Fig. 12. The DH is also used as a light bomber. Torpedo airplanes have been developed steadily from the R-6-L, P-T-2 and DT and, finally, the CS types.

It will be noted that the CS is operated as a bomber,

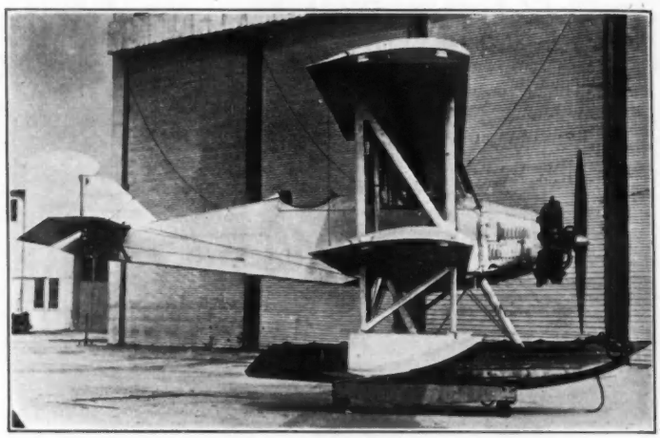

FIG. 8—THE BOEING NB-1 TRAINING SEAPLANE
After Careful Trials of Several Designs, This Tractor Biplane Has Been Adopted for the Future Training-Program of the Navy. It Is Convertible for Use on Land or Sea and Is Equipped for Gunnery Training. The Powerplant Is a Lawrance Air-Cooled 200-Hp. Engine and the Speed Range Is from 47.7 to 97.6 M.P.H. The Area of the Wings Is 344 Sq. Ft. and the Ceiling Is 11,150 Ft.

scouting and torpedo airplane; it has purposely been made a combination airplane, as all three purposes involve heavy weight-carrying and it is desirable to reduce

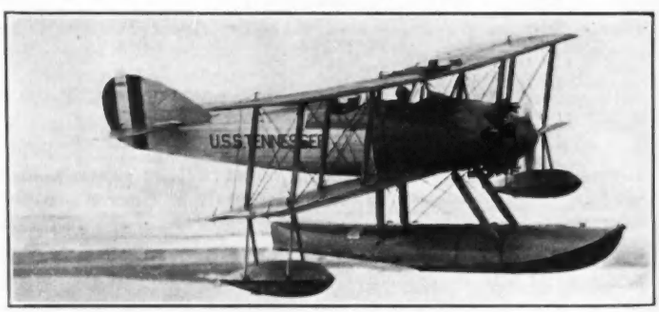

FIG. 9—THE UO-1 SEAPLANE
One of the Types of Machine Used for Scouting at Sea. This Seaplane Has a Wing Area of 290 Sq. Ft. and a Ceiling of 18,200 Ft. It is Equipped with a 200-Hp. Engine and Has a Maximum Speed of 122 M.P.H. and a Minimum of 53.5

the number of types required. At the same time, due to restriction on dimensions to permit its use from aircraft carriers, the design is a difficult compromise and performance is further affected unfavorably by the horsepower available in existing engines and also by the effort to combine three types into one. But, as soon as more

FIG. 10—UO-1 MACHINE EQUIPPED WITH LANDING-WHEELS
Although Seaplanes Form the Major Part of the Navy's Equipment, Airplanes Are Used in Connection with Aircraft Carrier-Vessels or for Launching from Catapults on Men of War. This View Shows a Scouting Airplane Employed in Such Service

powerful engines are available, the performance will be improved to a really satisfactory state. For scouting purposes, additional tankage replaces the bombs or torpedo load, and the cruising radius is better than 1500 miles.

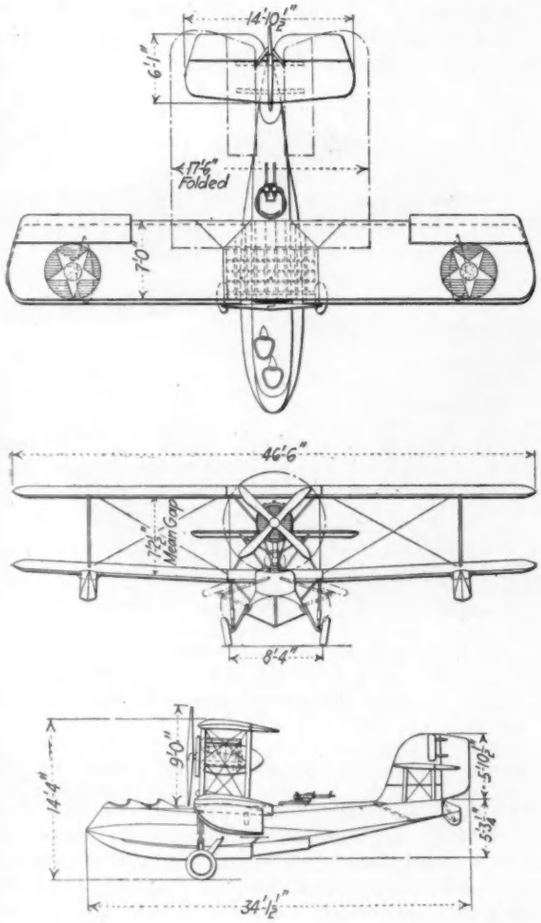

FIG. 11—THE NEWEST TYPE OF AIRPLANE FOR SPOTTING GUN-FIRE
The Amphibian VO-3 Will Be Able To Operate from the Catapults on Battleships and Cruisers or from the Deck of an Airplane Carrier, as Well as from the Surface of the Water or on Land, and Can Land on the Deck of an Aircraft Carrier. To a Limited Extent This Type Can Perform the Duties of Scouting, in Addition to That of Spotting Gun-fire. The Wing Area Is 625 Sq. Ft. and the Ceiling Is 11,200 Ft. The Powerplant Is Rated at 440 Hp. and the Speed Range Is from 50.5 to 104 M.P.H.

THE CATAPULT

The catapult is a distinct Naval development, although one must not lose sight of the fact that the first Langley planes and the first Wright planes were catapulted. The first successful catapult-shot of a seaplane was made at the Washington Navy Yard on Nov. 12, 1912, with the old Curtiss AH-3 airplane which, as originally delivered, was the first successful amphibian. The catapult design was revised in 1915 and, after trials on a coal barge at Pensacola, was placed on the North Carolina, after which the first successful shot was made from a ship under way. Then followed the installations on the Huntington and other cruisers but, as installed, this catapult, which is illustrated in Fig. 13, interfered with the gun-fire of the after-turret; this caused the removal of these catapults.

To overcome this difficulty, as the need for airplanes and catapults was recognized, a turntable catapult, shown in Fig. 14, was devised and twenty-five of them were

FIG. 12—THE LATEST DESIGN OF BOMBING SEAPLANE
The CS-1 Has Been Developed as a Combination Bombing, Scouting and Torpedo Machine, Since All Three Purposes Involve Heavy Weight-Carrying and a Reduction in the Number of Types Required Was Desirable. When Intended for Scouting, the Bomb or Torpedo Load Is Replaced by Additional Tanks, Giving a Cruising Radius of Over 1500 Miles

installed on battleships and scout cruisers. The problem is not a simple one. It requires accelerating an airplane from at-rest up to a speed of 50 m.p.h. in a run of less than 50 ft. This requires an acceleration of 2.5 g, where g is the acceleration of gravity, and reinforcement of the airplanes to withstand this thrust.

The first launching was accomplished in 0.9 sec. in a 30-ft. run, though from 1.5 to 2.0 sec. is used at present, depending on the amount of head wind and the weight of the plane being launched. At first the car which carries the airplane was shot overboard, though it was recognized that this would not do in service. The problem of stopping the car was solved eventually, but it was not an easy one because forces in the nature of 20 g have to be handled, so as to reduce the distance for stopping the car to the minimum, and the car weight must not be excessive. Up to this year, compressed air has been used for the purpose and the problems involved are thoroughly understood and solved.

LAUNCHING BY CATAPULT

The primary conditions are that the airplane must be made fast to the launching-car, so that it will not nose over while the engine is being warmed-up. Throughout the accelerated run it must be held fast to the car, so that the rolling of the ship and side winds will not cause the airplane to leave the car and also that, because the

center of gravity is well above the deck of the car, the acceleration imposed will not cause the airplane to turn over backward.

The launching procedure is about as follows: The airplane is secured to the launching-car, which is latched at the head of the run, the air-flasks are charged to suit the conditions of launching and the engine is warmed-up. When everything is ready, the catapult is trained into the relative wind as nearly as possible. When the pilot is satisfied with the conditions, he gives a signal, the catapult valve is thrown to the operating position and

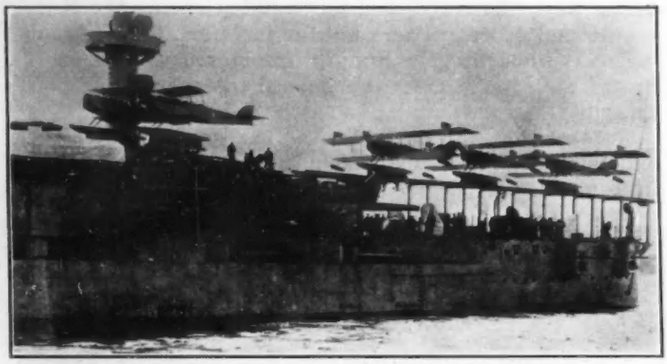

FIG. 13—THE CATAPULT INSTALLED ON THE CRUISER HUNTINGTON IN 1916
As Installed This Catapult Interfered with the Gun-fire of the After-Turret and It Was Removed

the car is released. It proceeds down the track under acceleration provided by the catapult engine until the car is about 1 ft. from the car-arresting device. At this point, the air pressure is released and the car and the airplane proceed together until the car hits the arresting device; then, the car being retarded, the airplane forges ahead, releases itself from the car and proceeds on its flight. Fig. 15 shows a turntable catapult while firing.

The latest development, of which I may not say much, is a powder catapult in which a powder charge is used instead of compressed air. It is illustrated in Fig. 16. This has been very successful, and the problem of controlled acceleration has been solved.

AIRCRAFT CARRIERS

We now consider the problem of the aircraft carriers fitted with a flying-deck. The humble Langley, shown in Fig. 17, with its maximum speed of 14 knots, has served a very useful purpose in determining the problems involved in flying-off and flying-on and in catapulting heavy planes. The most important problem has been

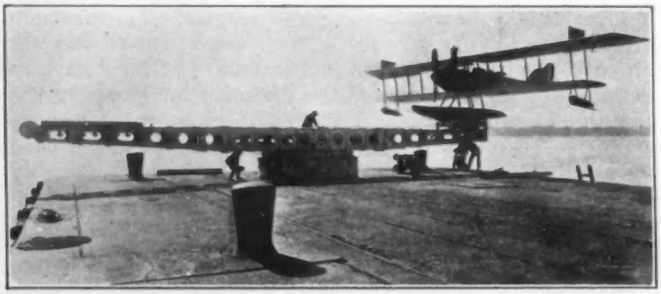

FIG. 14—THE TURNTABLE CATAPULT READY TO LAUNCH AN AIRPLANE
This Catapult Was Developed To Overcome the Difficulties Encountered with the Earlier Type Shown in Fig. 13. One of the Problems That Had To Be Solved Was the Accelerating of a Plane from a State of Rest to a Speed of 50 M.P.H. in a Run of Less than 50 Ft.

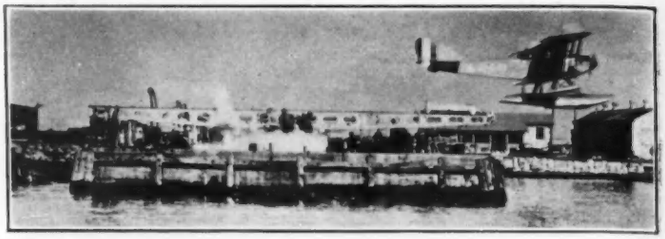

FIG. 15—LAUNCHING AN AIRPLANE FROM THE TURNTABLE CATAPULT
At Present an Airplane Is Launched after a 30-Ft. Run in from 1½ to 2 Sec., the Time Depending upon the Amount of Head Wind and the Weight of the Machine Being Launched

that of the arresting gear, for which a satisfactory solution has been found. For 6 hr. last winter, in trade-wind seas, airplanes from the Langley were kept in the air and returned to the ship successfully for refueling, although at the time the stern of the ship was rising and falling as much as 30 ft. I hardly need mention the commendation deserved by the personnel involved in this performance.

In combat-airplane development, we are following the Army practice closely, avoiding duplication of effort wherever practicable; but, even here, the problem of arresting and catapulting requires modifications which have their effects on the structure of the airplanes and, consequently, on their performance.

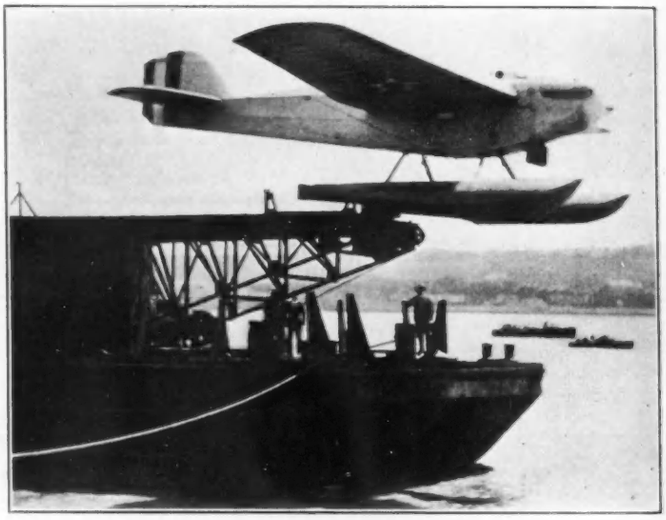

FIG. 16—THE LATEST DEVELOPMENT IN CATAPULTS
In This Catapult a Powder Charge Is Used instead of Compressed Air as Formerly To Launch the Plane. The Problem of Controlling the Acceleration Which Gave Some Trouble in the Earlier Design Has Been Solved

ENGINE, PROPELLER AND ACCESSORY DEVELOPMENT

As to engine development, although of course the Navy has not directly designed or controlled the complete design of any engines, I believe it is only fair to state that the Navy has encouraged the development and to no small degree assisted in and insisted on improvements in performance and reliability, as evidenced by the D-12, T-2, T-3, E-4, J-3 and the Packard-1500 types.

In propellers, too, the Navy has had its share in encouraging the remarkable development in alloy propellers. Unusual efficiency has been attained in service designs. This development has yet to solve the problem of serious erosion by salt-water spray in seaplane work.

In the development of flotation systems, both single

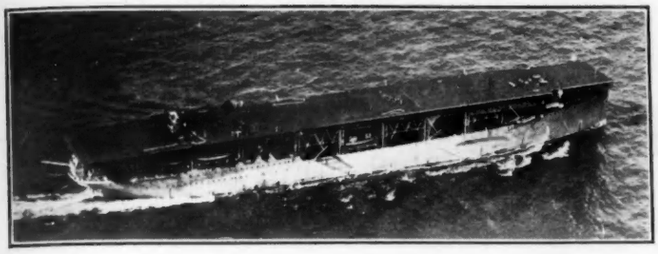

FIG. 17—THE AIRCRAFT CARRIER LANGLEY
This Vessel Is Fitted with a Flying-Deck and Has Served a Very Useful Purpose in Determining the Problems Involved in Flying From and Landing On the Deck, and in Catapulting Heavy Planes

and twin-float, and in "single-float" I include floats of the boat type, I believe that, through the influence of the model-basin experiments on designs, ours are the equal or superior to any foreign development; and I think we shall hold this lead. There is still a controversy over single and twin-float types, but I believe the twin-float type is only excusable in small-span planes where tip-floats become awkwardly large, or where, as in torpedo or bombing planes, it is most desirable to have the load centrally disposed.

We naturally have had to participate in the development of accessories for navigation, for navigation over the seas is no less important than night-flying or flying in thick weather; and these problems are in hand also. In accessories for communication, we are making satisfactory progress; but that does not mean that we are satisfied. In powerplant accessories, our demands have been fairly well met and satisfactory improvement has been made, particularly in the problems of cooling and the control of oil and water temperatures in cold weather.

In ordnance accessories, such as bombs, bomb gears, sights and torpedo directors, steady progress can be noted. In all this development, unnecessary duplication is avoided by maintaining close contact with the Army practice, although a healthy rivalry exists. In several instances, independent solutions of the same problems are sought, to the advantages of both branches of the service.

LIGHTER-THAN-AIR CRAFT

In lighter-than-air craft, the ZR-1 or the Shenandoah, Fig. 18, is strictly a United States naval achievement in the design and construction. I need not tell you the details of the success of this first venture of American designers into a new engineering field, or of the new industry involved in the production of the metal required and its fabrication into a mechanically sound structure, or of the successful construction of the gas-bags and the numerous accessories called for by the special and new requirements.

From the foregoing, I think it will be understood clearly that the Navy has some problems peculiar to the operations at sea, and that real progress has been made toward making the fleet more effective through the use of aircraft.

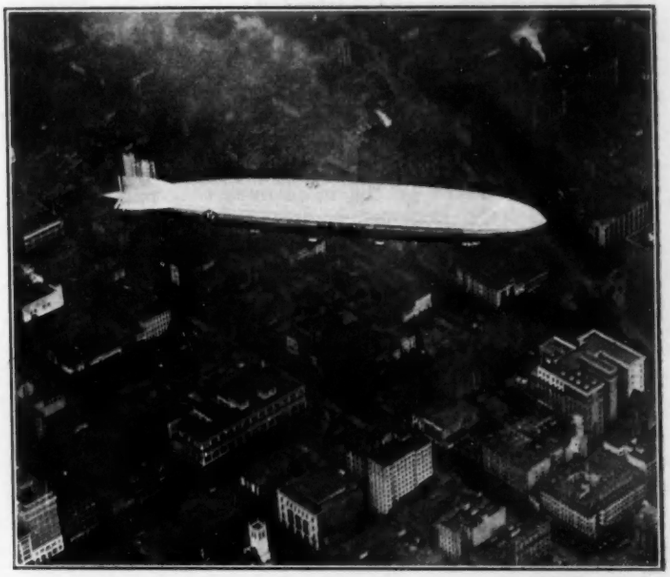

FIG. 18—THE SHENANDOAH FLYING OVER THE CITY OF WASHINGTON
This Lighter-than-Air Craft Is Strictly a Naval Achievement in Its Design and Construction

NEEDED IMPROVEMENTS IN CARS

PENDING the evolution of the ideal motor-car with infinitely variable transmission, a noiseless, vibrationless prime-mover, perfect braking, effortless control and the like, we should at least perfect the mechanism in use at the moment. In 1924 no excuse for squeaking, ineffective brakes exists, neither should we have poor fuel-consumption, or steering gears that are stiff or unmanageable. There are also the lesser evils of vibration, bad clutches, difficult gear-changes, excessive noise, and other drawbacks, all of which can be found on one or another of the moderate-priced cars.

Many of the lower-price vehicles quickly become shabby, a vastly improved performance and manageability. Nearly every steering-gear can be made easy, and driving comfort can be secured by proper attention to such details as clutch, steering and gear change.

Many of the lower-price vehicles quickly become shabby, though it may be admitted that in the many cases this deterioration is accelerated by neglect. A little care will keep even a cheap car in good condition for a fair period, and in any event durability is much more important in the chassis itself. It is vital that cars should run for considerable periods without serious attention, such as bearing renewals, valve-grinding and decarbonization.

Cars that are tiring to drive will have to disappear, and the purchaser of the small vehicle will expect something practically as good in its way as the larger and more expensive cars. There is no reason why we should not have this; one or two of the little cars of today, in their ease of handling, approach very closely to the more expensive vehicles.

In the matter of suspension much, of course, remains to be done. Not only are small and moderate-size cars weak in this respect, but in nearly all cars there is room for improvement. It appears at the moment as though some sort of a compromise will be effected by employing tires of exceptionally large section, a method thoroughly sound theoretically. This, however, still leaves some aspects of the problem unsolved, particularly that of steadiness, and the suppression of rolling on corners and when negotiating curves at speed. On the face of it the difficulty appears an insoluble one, by virtue of the fact that two opposing conditions are met, namely, straight-ahead travel on the level, and travel on camber or round bends, where external influences come into play. Soft suspension means rolling under these conditions, yet any check on rolling reduces comfort.—*Automobile Engineer.*

Possible Economies in Automotive Machine-Shop Operations

By A. L. DeLeeuw[1]

PRODUCTION MEETING PAPER

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

THIS paper is confined to a discussion of machine-shop operations, and is intended to indicate by a few examples certain important economies that might be introduced in the shops of the automotive industry. It deals chiefly with the economies that can be effected without much capital outlay, though others are also mentioned. Calling attention particularly to the fact that, in the past, improvements of methods and of equipment have been confined largely to the more important operations on the more important parts, and that relatively little study has been made of the smaller pieces and the less important operations, emphasis is placed on the necessity for carefully determining which tools and which makes of tool will best serve the purposes for which they are intended, and for carefully sharpening the tools and providing means of setting them accurately. The various auxiliaries are discussed and, in order to confine the paper as much as possible to actual cases, one definite operation, namely, drilling, has been chosen as the chief example.

THE campaign for economical production in the factory may well be compared to the campaign of an army. In both cases there must be a general strategy, a plan that, if carried out, will lead to success. There must be, also, the proper tactics, for however brilliant the plan of the strategists may be, it is bound to fail unless the tactics employed are correct; and, similarly, no tactics, however well thought out and applied, can lead to permanent success unless the general strategy is sound. The comparison may be extended still farther. The best general will fight a losing battle unless he is supported by a good army, well-officered; and even that is not sufficient unless the quartermaster's department supplies the munitions of war when and where required.

This paper does not concern itself with the general strategy of a factory, but purposes to take up some of the phases of the tactics employed. To revert once more to the simile used, it may be said that such items as the officers and personnel of the army are given a great deal of attention in the factory, that the movements of troops, the routing and the dispatching have been given the most careful thought and that, excepting a few badly managed factories, the supply of materials is well taken care of.

There remains, however, the use of the munitions of war.

Dropping the analogy, it may be said that most of the phases of factory economy have been studied profoundly. The general layouts of shops, methods of handling material, routing systems and the like have been improved; and it has been accepted by practically every uptodate factory that no success can be expected unless these matters are studied, systematized and rigidly controlled. This applies not only to the workshops of the automotive industry but to practically all shops of the larger sizes. The thought has become almost instinctive that efficiency methods in the shop refer to methods of control. In some instances the actual work to be done also is carefully analyzed, but, as a whole, the actual methods of production are based on existing practices, rather than on what should be done, and are often left in the hands of minor officers, men who, on account of lack of early preparation and limited experience, have not had an opportunity to acquire the broader vision that is so necessary for real progress. The writer in his work as consulting engineer has had a great many opportunities to observe this lack of thorough detailed study of the actual operations of factories; it is with this phase of the general economy that this paper will deal.

CLASSES OF IMPROVEMENT

Generally speaking, improvements in machine-shop methods may be divided into three classes: (*a*) the class requiring no capital outlay; (*b*) the class requiring a small capital outlay that cannot be considered as an asset but should be figured, partly at least, as an expense; and (*c*) the class depending on the capital outlay that becomes an asset.

In bringing about reduction in costs, the first-mentioned class of improvements should be considered first. This does not refer to positive shortages that might be found by an examination of the equipment, gaps that should be filled in any case, whether improvements are intended or not. To make improvements with a view to reducing costs without a capital outlay does not necessarily mean that there will be no initial expense; but when this method of reducing costs is employed, it should be a rule that every improvement should pay for itself within a year.

As an illustration of what may be done along these lines, a few of the every-day operations in a machine-shop will be taken up, beginning with the operations of drilling.

Drilling, one of the simplest operations, requiring no particular skill or expensive equipment, is not always done with proper regard for the magnitude of the operation as compared with other operations in the shop. Much study may be given to milling or the boring of cylinders, because the cylinder is one of the main parts of the finished product; yet it will be found that, as a rule, many more men are employed in drilling holes in minor pieces than are engaged in the main operations on the cylinders. It is true that greater economy can be effected in a single operation on a cylinder block than in a single operation on a minor piece; but, as most of these economies have already been effected, the possible economies on the minor pieces are now greater than the gains that may be made by any further improvements in the performance of single operations on the major pieces.

[1] Consulting engineer, New York City.

Economy in Drilling Holes

The greatest possible economy in the drilling of holes is reached when the greatest possible number of holes is drilled at one time, when the holes are drilled at the greatest possible rate of penetration, when man and machine are both occupied all the time, and when no delay occurs because of breakdowns. Though these ideal conditions may never be reached, each of the points mentioned can be closely approximated, provided that the necessary study is given to the subject.

As the drilling of a number of holes at one time requires multiple-spindle machinery and as this may necessitate capital outlay, this means of obtaining greater production will not be considered at the present moment. The second point is that the drills should work at the greatest possible rate of penetration. In order to accomplish this, a study must be made of the drill itself and of the material to be drilled.

A number of years ago, the writer, then chief engineer of the Singer Mfg. Co., had a series of tests conducted to determine what make of twist-drill should be specified. These tests consisted of drilling holes in steel plates at various rates of speed of the drill. All drills used were 5/16 in. in diameter. Practically all the makes of twist-drill manufactured in the United States were tested. The feed-pressure was obtained from a weight hung over a pulley. The time required for penetration was determined by a stop-watch. The test was discontinued when the time required for the penetration of the plate had become 50 per cent greater than it was at the beginning of the test. Various speeds were used, but the speed to which the greatest attention was given was 1800 r.p.m., which is about 150 ft. per min. For drills that showed the best performance the speed was run up to 2300 r.p.m., or about 180 ft. per min. All plates were of mild steel, about 0.20 per cent carbon, comparable to the No. 1020 S. A. E. Standard, and ¾ in. thick. Standard test-drills and standard test-plates were kept on hand for the purpose of testing each new plate with a standard drill and for testing the sharpness of each new drill with a standard plate.

It was found that many of the precautions were rather unnecessary on account of the enormous difference in the behavior of the various makes of drill. Some makes of drill would drill 600 holes before becoming dulled to a 50-per cent-greater time, whereas others would breakdown completely after drilling two holes.

After the best two makes had been determined by this method, drills were purchased at a hardware store, to eliminate all possibility that selected drills might have been furnished for the test.

These tests are mentioned to show how important it is that a proper study of the drill itself be made. The difference in performance indicated above is so great that the idea must be discarded that any standard make of twist-drill is about as good as any other. As a result of the tests a general speeding-up of drilling operations was made possible.

Failure of Cutting-Tools

Though it is a well-known fact that the complete destruction of a tool takes place in a very short time after it has begun to fail, this common knowledge is not universally put into practice. As a rule, tools are not replaced until after they have failed, whereas they should be replaced before the failure takes place. The curve that indicates the gradual failure of a tool is not a downward-sloping straight line, but is a line that remains practically parallel to the base-line until the last, and then suddenly dips down. In the drill test mentioned above, it was found that after drilling one or two and sometimes half a dozen holes the time of penetration was reduced, not increased; the time would then gradually creep up to the original time, and would remain constant or nearly so until very shortly before the time when the 50-per cent excess was reached. For instance, if the time of penetration with one of the good drills was 14 sec. it would be found that this time would be reduced to perhaps 13 sec. after drilling a few holes; that at about the 20th hole the time would be 14 sec. again and would remain practically constant, increasing perhaps to 15 or 16 sec. until 590 holes had been drilled; then, in the last 10 holes, the time would suddenly increase from 15 to 21 sec. Furthermore, it was found that complete failure would follow shortly after, if the test was continued. The figures given here are illustrative, as the performance was slightly different with different makes.

The reason that it is important that drills, and for that matter tools in general, should be replaced before they begin to fail is that the man in the shop will consider a tool's behavior while in the period of failure as its limiting capacity. It is but natural that he should consider the tool as he takes it out of the machine and draw conclusions from its appearance, because he is ignorant of the fact that this appearance has been brought about in the last few minutes. It is therefore to be recommended that the behavior of tools be studied and a schedule made up as to the length of time they should be left in the machine; and it should be made compulsory to change tools after stated intervals.

Saving By Frequent Replacement

Another point in favor of the replacement of tools before failure is the following: When a tool is removed before failure, only a very small amount of grinding is required to restore it to its original condition; but when complete failure has taken place a large amount of material must be ground off. If failure has been caused by overheating, there is a possibility that part of the tool will have become decarburized. This condition is not always visible, so that a tool may be resharpened and appear to be in fine condition yet fail after a very short amount of service because the parts at the cutting lip are soft. Both the amount of work involved in resharpening and the amount of material of the tool that is wasted are reduced in reconditioning the tool before failure. It should be emphasized here that this holds good not only for drills but for all cutting-tools.

Failure of drills takes place by breakage, by abrasion and by heating. Breakage is generally a result of too much feed per revolution, though there are other reasons, such as blow-holes, too much looseness in the feed mechanism and the like. Abrasion cannot be avoided and merely affects the sharpness of the tool; this may be overlooked if the proper system is used for replacing the tools. Overheating may be due to too much feed, or too great speed, or the continuous use of the tool after it has begun to fail.

Importance of Evenly-Ground Lips

There is a combination of feed and speed that will give the greatest amount of penetration per unit of time. The elements of this combination depend on the diameter of the drill, the material of which it is composed, its method of heat-treatment, and the nature of the work.

Once these elements, feed and speed, have been determined, it is important to have the conditions such that this feed and this speed can be used consistently. Let us suppose that it is found that 0.008-in. feed per revolution gives the best results. That feed means that each lip of the drill is capable of taking a chip 0.004 in. in thickness. If a higher feed is used, an untimely breakdown of the drill will occur, or the speed must be reduced; but, in any case, the output will be unavoidably reduced. If the drill should be ground so that one lip takes a heavier chip than the other, it will mean that a chip 0.004 in. thick is taken by the lip that does the heavier work. If there is a difference of 0.002 in. between the two lips, the total amount of feed can be only 0.004 in. plus 0.002 in., or 0.006 in., and the penetration will be reduced 25 per cent. This shows the extreme importance of grinding the lips of the drill to an exactly even length. My observation has shown that this is the exception rather than the rule. Without fear of overstating the condition, I am convinced that in the average shop practically no drill at work takes two even chips and that if there were such a drill it would be more the result of accident than of intent. Automobile factories do not seem to make an exception to this general rule.

To recapitulate: In order to obtain the greatest possible penetration per unit of time the proper drill should be selected, its proper combination of feed and speed for the drilling of a given material should be determined, the lips should be ground as nearly as possible of even length, and a period should be established for the active life of the tool before it is resharpened.

Arrangement of Work

The next important point to be considered, when the maximum production and the minimum cost are the objects, is to arrange the work so that both man and machine shall be occupied all the time. This does not mean that there shall be driving of the man. The rate at which a man can work is one thing, and his enforced idleness, because of nothing to do, is another thing. As to the machine and the tools, no humanitarian reasons will prevent them from working at the highest possible rate of speed.

Among the causes that prevent men and machines from being occupied all the time are the following:

(1) The machine is necessarily non-productive while the man is loading a fixture
(2) The man is necessarily non-productive after he has started the machine
(3) Man and machine are both non-productive while the man arranges or removes a quantity of work

The time during which the machine is non-productive while the operator is loading a fixture may be reduced by the careful construction of the fixture itself. It is desirable, though not always practicable, to construct the machine so that a single movement will place in position and clamp the work. Means should also be provided to free the fixture quickly from chips. A tank, suitably located, containing water or oil, or, better yet, an ample low-pressure stream of water, will accomplish this result. When the latter method is employed it is advisable to have a low-head centrifugal pump for providing the water, or possibly oil, for one or preferably a number of machines.

The time during which a man is non-productive after he has started the machine can only be reduced by doing the work at the highest possible rate. When a machine is available for work at this rate and when the proper feed and the proper speed have been determined and the proper tools have been provided to maintain this feed and speed, nothing further can be done to shorten this period of waiting.

The third item, that the man and the machine are both non-productive while the man is arranging or removing a quantity of work, deserves attention, even when none of the other methods to be mentioned later is resorted to.

Cost of Non-Productiveness

Suppose, for the sake of illustration, that the annual wage of the man is $1,500 and that the annual cost of the machine, composed of interest and depreciation on the machine and the floor-space, is $150, and, further, that 10 per cent of the man's time is given to taking the stock from boxes and barrels, to placing it where it will be convenient to handle, and also to reloading it in boxes and barrels after it has been machined; then this part of the operation will cost annually $165. Suppose further that a laborer were employed to do this work and that his annual wage were $1,200; such a laborer should take care of 7.5 machines in order to earn his wage. Even if no further advantage were gained, the advantage of obtaining increased production without further capital outlay would still remain. As a matter of fact, however, such a man would certainly be able to take care of 10 machines; in this case he would produce a value of $1,650 for a wage of $1,200. As the machines that he attends become more and more valuable, the value of his services increases proportionately. To a certain extent this idea is carried out by having laborers bring boxes containing work to the machine and remove the finished work again. The old system of having each mechanic lug his own work to and from the machine has long since been discontinued, but the new system of dividing the work between the mechanic and the laborer has not been carried out to its logical end. In some cases the handling of the work is facilitated, when the quantity of the work allows the use of some kind of conveying-system, but a large percentage of the work cannot be handled in this way, and in such cases a laborer should be appointed to serve as many machines as may be convenient.

Reduction of Non-Productiveness

The first item, the non-productive period of the man, can be reduced in various ways; whatever way is employed carries with it, at least to a certain extent, a reduction of the idle time of the machine. Several different ways can be followed. Loading fixtures are sometimes used, in which case one fixture is loaded while another is at work. If it happens that the time for loading and the time for machining are practically equal, this method approaches the ideal. Such cases, however, are rare. Double or possibly triple fixtures are usually required and this additional cost may not be justified. When this method is employed, a still further reduction in time can be accomplished by indexing-tables or automatic multiple-indexing fixtures. All such schemes, however, belong to the class of methods in which a small capital outlay is required and this capital outlay does not produce assets in the true sense of the word.

As a rule, it is possible to group machines so that one man can operate more than one machine. If, for instance, it takes 10 sec. to load a fixture and to start a machine and 30 sec. to drill the holes, one man should be able to run four machines. In such a case each machine is idle one-quarter of the time, but the man is busy all the time. Comparing this method with that in which each man runs one machine only, and assuming again

the same figures for wages and machine cost, the following comparative figures are found: By the first method, the machine costs $4 \times \$150 = \$600$; the man's labor is \$1,500; and the total will be \$2,100. The four machines each produce the same amount that would have been produced if there had been one man per machine, so that the total output is valued at $4 \times \$1,650 = \$6,600$. Following the second method, this same product would have been produced by four men and four machines, at a cost of $4 \times \$1,650 = \$6,600$; so that the same product is in one case produced at a cost of \$6,600 and in the other at a cost of \$2,100.

These figures are illustrative only and must be modified according to the value of the machines used, the wages paid and the extent to which such a scheme can be carried out.

Effect of Variations in Loading Time

In the foregoing it was assumed that a very simple and constant ratio exists between the loading and the drilling times, and that these times were the same for all four machines. In practice it will be found that a certain unavoidable variation occurs in the loading time and that it is exceedingly difficult to have at all times four jobs for four machines, all of which have the same loading and drilling time. As a consequence, the figures given above must be modified. It is highly probable that on an average run of work only a fraction of the final economy can be attained. Nevertheless, it is almost always possible to group simple operations to obtain at least a part of the ideal reduction in cost.

When such a grouping of machinery is resorted to it is highly desirable to place the machines so that the minimum amount of walking will be necessary in serving them all. Whenever possible the machines should be grouped around the man and not in a straight line. When the nature of the product is such that the same group of machines can work on the same product all the time, a permanent location of such a group of machines is desirable. But when the work is shifted, it would be advisable to have the machines so arranged that they can be easily relocated. This, of course, requires motor-driven machinery that can be lifted with a crane and placed in position at any time. This method is followed nowadays in a few factories where conditions allow it.

A certain amount of ingenuity is required to group the work in the way to obtain the greatest possible economy, but this ingenuity is of no higher order than that which must be displayed by a dispatcher of railroad trains. It is seldom that jobs are so related as to the quantity and the time required for operation that a perfect combination can be effected. For instance, when 100 pieces require 30 sec. for an operation and 50 other pieces require a full min., the combination is perfect; but if 100 pieces require a full min. and 50 other pieces require 30 sec. a piece, the combination is defective; but this does not mean that some grouping is not possible. The fact that an ideal is not obtainable should not deter us from aiming at and hitting it as nearly as possible. The labor required to plan such grouping and arranging of work is the chief source of the expense to which reference has been made.

Much more could be said about the things that can be done to reduce costs by careful planning. But, as all that can be said in this paper must necessarily refer to imaginary figures, I believe that sufficient indication has been given of the possibility of effecting economy without capital outlay. The next class of improvement to be considered is that requiring some capital outlay for jigs, fixtures and other accessories for the work of drilling.

Accessories Reduce Costs

Among these accessories may be mentioned indexing-tables, semi-automatic fixtures, special devices for lubrication, and the like.

Indexing-tables are particularly useful when the work of loading is greater than that of drilling. Such devices apply, therefore, especially to multiple-spindle drills and, more especially yet, when the work to be drilled is large and cumbersome to handle. When such a machine is used it will be found that the machine cost is high and that the machine is idle a large percentage of the time. If, for instance, the actual work of drilling is done in 2 min. and it takes 3 min. to remove a piece and load another one, we have the following set of conditions: The machine cost per year will be 15 per cent of \$5,000, or \$750; the labor cost will be \$1,500; and the total cost will be \$2,250. The machine is occupied 2/5 of the total time.

If now a special fixture or indexing-table is furnished and two men are used for loading, so as to bring the loading time within the machining time, the same amount of work will be done in 2/5 of a year; so that the machine cost for the same amount of production will be 2/5 of \$750, or \$300. The labor cost in this case will be 4/5 of \$1,500, or \$1,200, and the total cost, \$1,200 plus \$300, will be \$1,500. This is a saving of \$750. An indexing-table would be an asset. On the other hand, a double-swinging fixture could not be considered as a permanent asset and should be written off as expense. This expense should be covered by the gains in one, two, or possibly more years.

If the time of loading should happen to be about the same as that of drilling, then we should have the following set of conditions: Using a single fixture and one man, the cost per year again will be \$2,250, and the machine will be occupied ½ the time. Using a special fixture or indexing-table, the same amount of production would be obtained in ½ year; in which case the machine cost would be \$375 and, as only one man is now employed, the labor cost will be \$750 or a total of \$1,125. Whether this arrangement or the previous one should be used will depend on whether it is possible for one man to load the fixture in 2 min., or a helper would be required. The examples given are merely illustrative. It will be seen that an analysis of each individual case will be required before a decision can be made.

Automatic Stock-Feeding Devices

A class of device that can be applied to drilling-machines, and for that matter to other machines as well, includes the automatic stock-feeding devices, such as hopper feeds, magazine feeds, dial feeds, and the like. There is good ground for a difference of opinion whether such devices should be classed among accessories or among permanent additions to the machine. It is sometimes one, sometimes the other.

Except in a very few cases the hopper feed finds no place in the automotive industry. Hopper feeds are economical when large numbers of pieces must be machined year in and year out; these devices are "at home" in large-quantity manufacturing. The difference between a hopper feed and a well-developed magazine-feed is that, in the first case, the material is dumped into the hopper without regard for the position it takes, and depends on the hopper to rectify its position and bring it to the machine in the proper manner. In the case of

magazine or dial feeds, the material is placed in position, not necessarily in the position that it must have in the machine, but in some definite position, depending on the construction of the magazine. Consequently, the economic difference between these two classes of device is merely that the operator spends less time in supplying material to one machine than to the other and, unless such a machine can be kept on one operation continually, unless a hopper can contain a large number of pieces at one time, unless the hopper is not liable to cause trouble, and unless such a hopper device can be developed at moderate cost, no economic reason exists for employing such a device at all. Notwithstanding the best skill of the designer, a hopper device almost always requires some experimental development to eliminate what the shopman calls "the bugs." For this reason alone it is doubtful whether hopper devices are of any economic importance in the automotive industry, except for some standardized articles, and these, as a rule, may be bought outside. Among articles of this kind, ordinary nuts, castellated nuts and the like may be mentioned.

Magazine and Dial Feeds

Magazine and dial feeds are devices belonging to the same class. Both are magazine feeds. The particular kind of magazine feed to be used for any one piece depends on the nature of the piece, the work to be done, the machine on which it is to be done. In a dial feed the pieces are placed as a rule, in such positions that they are presented to the machine ready for the operation. The pieces may be held by a device operated by the workman or by the movements of the machine itself. In a magazine feed, as distinguished from the dial feed, pieces are not arranged or held in this manner, and additional parts must be provided to fasten the piece in the proper position. In the automotive industry, a great many pieces are suitable for such magazine or dial feeds, but whether the devices should be applied must always depend on an analysis of the economic conditions. The life of the piece, that is, the number of years during which it may be expected to be used, the cost of the device, the saving in labor cost, and the like, must all be considered. Such points can only be indicated in this paper.

Drilling-machines lend themselves particularly well to the application of such devices but, on the other hand, the saving to be accomplished is not quite so great as it may be in other types of machine. It stands to reason that the greater the cost of the original machine and the greater the amount of floor space that it occupies, the more inviting will be the application of such a device.

Chucking Devices

Another class of device that may be employed either alone or in combination with magazine feeds is the pneumatic or hydraulic chucking-device. As a whole, it may be said that these devices are not employed as much as they deserve. One reason that pneumatic devices are looked upon with some distrust is that the pressure in the air-line may vary to such an extent that the chucking will become uncertain. This is not a defect of the pneumatic devices themselves, however, but is caused by the fact that they are operated from the main air-line, which is used for such a variety of purposes and in so irregular a manner that an uneven pressure results. The proper manner of applying pneumatic devices is to have a small compressor for each machine or, better, for a group of machines. When this is done it will be found that the air pressure is sufficiently constant to allow the use of air-chucks without appreciable trouble. When hydraulic devices are used an accumulator should be installed to provide constant pressure. Such hydraulic devices do not cause trouble, because the pressure can be kept low. They allow smaller cylinders to be used because, even though the hydraulic pressure may be low, it may be considerably higher than would be practicable for a compressed-air line. On the other hand, the question of drainage must be considered and may at times be sufficiently serious to condemn an hydraulic installation.

The hydraulic or pneumatic chucking-device will be found particularly useful with magazine or dial feeds.

Dial feeds are most commonly used for small presswork, but one of the reasons that the pressman hesitates to install such a feed is the difficulty of obtaining the proper relation between the dial feed and the die. In such cases this difficulty may often be overcome by lifting the piece out of the dial and placing it in the die by means of suction. I have used this system for various purposes and have found it to be reliable and successful. A single vacuum-pump may be used for several machines. Not only presswork but polishing and buffing can be expedited in this manner.

Conveyors

In drilling, reaming and tapping some of the larger pieces, various devices are used to facilitate transferring them from one machine to another; principal among these are conveyors and the track-and-trolley system. The same principles apply to small pieces on which various operations have to be performed. In some shops gravity-conveyors lead from one machine to another but, after all, these are merely a means of handling the pieces between operations, each operation being performed by different workmen. This general scheme may be modified when machines with automatic feed are used. These machines may be grouped so that the spindles are spaced at regular distances apart and a conveyor may be used to move the pieces automatically from one spindle to another, when the spindles have returned to their starting-points. A conveyor must have definite locating-points, and a workman is supposed to place the work at these points. Another possibility is that the conveyor may merely pull the pieces from one position to another and locate them approximately, while a fixture at each machine locates the piece definitely by means of some auxiliary chucking-device, such as an air-piston or a cam-lever.

Many of the last-mentioned devices call for machinery that is more or less automatic in its action. In this connection, it should be pointed out that a large quantity of machinery in use at the present time does not possess these automatic features. I have noticed that a great many sensitive drills, hand tapping-machines and even lever-feed drill-presses are still in use in the automotive industry. This leads to the consideration of the third class of improvement, namely, the devices and processes that require an initial capital outlay. I wish to point out that although drilling and affiliated operations have been used as examples pointing toward different means of improvement, these remarks are, to a large extent, also applicable to other operations.

The Sensitive Drill

The simple sensitive drill has very little place in the automotive industry. It is peculiarly effective when very small holes can be drilled only with difficulty and a power feed cannot be used with safety. It is differentiated

from the lever-feed drill-press merely by the fact that a short lever, instead of a long one, is employed, so that it is not possible to apply heavy pressure to the drill. Even at that, such a machine is not sensitive unless the operator makes it so. For ordinary manufacturing operations the sensitive drill-press and the lever-feed drill-press are of the same type.

It is often maintained that the lever-feed drill-press is particularly effective for operations that do not require a very accurate hole, because the workman, especially if he is working on piecework, will, using shop parlance, "punch the hole through." This assertion has very little truth because there is no reason that a power-feed drill-press cannot give the same feed as the hand. Furthermore, a hand feed is necessarily irregular, and the drill suffers in proportion to the maximum pressure put on it. With power feed, this pressure is always the same and can be limited to what is correct for both the drill and the work. Taking it all in all, then, it may be said that neither the sensitive drill nor the power-feed drill should be used in the automotive industry, a few cases only being excepted.

Machines are now in the market that allow the operator to be engaged constantly in loading pieces while the machine does the drilling. Such a machine has, of course, a number of spindles, some or all of which may be used according to the relation existing between the time of loading and the time of drilling. If such a machine has six spindles and it takes 5 sec. to load and 15 sec. to drill, no benefit is to be derived from using more than four of them; but if the time of loading is 5 sec. and the time of drilling 25 sec., all six spindles can be used to advantage. Here again the controlling principle is to keep both the man and the machine occupied all the time.

These machines need not be used on a single piece. The quantity of a single piece may not be sufficient to justify the machine's being set up for one piece only, especially if special fixtures must be made, because a six-spindle machine would require six fixtures whereas the amount of work might justify only one. But there is no reason that such a machine cannot be set up for several different pieces at one time. One piece may require a single fixture, another two fixtures, and so on. As has been pointed out, it may be difficult at times to group the work so as to have both machine and operator work all the time but, with some exercise of judgment, it will be found possible at all times to group a sufficient quantity of work so as to get at least a large percentage of the maximum benefits.

A wide field exists for the use of mutiple-spindle tapping-machines, properly arranged gang-drills, and what might be called combination machines, machines that will do drilling, reaming, facing, tapping and the like in the same way that a multiple-spindle automatic screw-machine performs its operations.

Development of Special Machines

The automotive industry has not yet been sufficiently standardized to make the development of special machines entirely safe. On the other hand, most of the ordinary standard machine tools may be called over-developed for this industry. Wide range of feeds and speeds, universal adjustments, and the fact that they allow a wide variation in the dimensions of the work make them suitable for jobbing work, but too complicated and, consequently, too expensive for what is required of them in the automotive industry. It is seldom that a machine must be changed over from one piece of work to another; consequently, the total amount of time spent on the machine during a year in arranging it for new pieces of work is but a small percentage of the entire year's performance. Quick adjustment and change from one feed or speed to another are essential in machines for jobbing work but are of little importance in the automobile shop. A few of the simpler machines are now in the market. Machines that have recently been developed for automobile work have usually been constructed along simple lines. This tendency should be encouraged.

To recapitulate what has been said about possible improvements in drilling practice: More attention should be given to the proper selecting and sharpening of tools, to the grouping of operations, and to the planning with a view to keeping both the man and the machine employed all the time. Wherever economical, indexing-tables, conveyors and the like, should be used. The use of sensitive drills and lever-feed drills should be stopped; and, as a whole, the question whether single-spindle or multiple-spindle machines should be used ought to be studied in every case. It should be kept in mind that even when conditions do not justify an expensive multiple-spindle machine, multiple-spindle heads may be used to advantage. Automatic chucking-devices and magazine feeds should be employed to the largest possible extent.

To survey all the possibilities for improved production in an industry as large as the automotive industry is entirely beyond the scope of this paper. The writer has selected machine-shop operations, not because they are the most important ones, but because they are of a more uniform nature and allow more definite discussion. Even with this limitation, the subject is entirely too large for this paper, and for this reason the writer has confined himself until now to a few high points of a single class of operation.

Application of Principles to Milling

Most of the remarks made apply to other operations as well. To take, for example, milling operations, here again great benefits may be derived from a careful selection of cutters and their proper sharpening. The lack of uniformity of cutter practice in a single shop is rather surprising. Though I am fully aware that local reasons may account for such a lack of uniformity, I do not believe that as a rule these reasons are of sufficient importance to govern the output of so important a department as the milling department. In this connection likewise it has been my experience that cutters of different makes differ greatly, and that it would pay well to investigate carefully which cutter will give the greatest output per dollar invested. Simple rules, such as the use of the smallest possible cutter compatible with an arbor of sufficient strength, are rarely followed in the average shop.

I have seen fixtures so arranged that the cut has a tendency to pull the work up, whereas it might have been arranged just as easily to bring it down. A striking instance of this lack of detail study was presented by three duplex-millers, all working on the same operation and on the same piece. In the first machine, both cutters were running in a direction that pulled the work up; in the second machine, both were working in a direction that pushed the work down; and in the third machine, one cutter pulled up while the other pushed down.

Not only was a wide variation found in the practice of different shops, but even in the milling practice of a

single shop, and even within a single department in any given shop.

It is not my intention to criticize the conditions that have been mentioned, but rather to point out opportunities for increasing the output and lowering the cost without capital outlay and without rearranging departments, merely by carefully studying the conditions. That the necessary ability or even manpower, may not be available for making such studies is neither here nor there. The point is that opportunities for reducing cost occur and should be grasped whenever possible.

End-Mills and Gang-Mills

Among the things that can be done to cheapen production, without requiring a material outlay of money or a change of equipment, are the more extensive use of end-mills, the use of gang-mills, especially arranged for some definite operation and kept for that purpose only, and the application of stream lubrication. The last-mentioned item is very productive when it can be applied. That it cannot be applied to cast-iron work, and is not easily applied to end-mills or to face-mills, is not a good reason for not applying it at all. The only equipment required for stream lubrication, in addition to the regular equipment, is a centrifugal pump or, generally speaking, some source of supply of a large amount of lubricant or coolant under low pressure, a guard around the table of the milling-machine, and some means for draining off the liquid. In addition, a shield closely enveloping the cutter must be provided. As against these small items of expense may be mentioned the fact that in many cases the speed of the cutter can be doubled, tripled, and sometimes even decupled, over that which would be possible in ordinary practice. It allows the rapid production of pieces that on account of their frailty, or the impossibility of holding them rigidly, do not allow a heavy feed to be employed.

Among the methods of milling that should be employed to a much larger extent than they are employed at present are continuous milling with the help of a rotating table, either on a vertical or on a horizontal machine, the use of loading-fixtures, and semi-automatic and automatic milling.

As to the needs of the automotive industry for new types of machines, I would mention very small semi-automatic millers, for light cuts on the smaller pieces, and multiple-spindle milling-machines. The first-mentioned class finds only limited application but is profitable when it can be used. I am drawing on my own experience in making this statement. The second class, multiple-spindle millers, is not at present in existence as standard tools, and might be too expensive if purchased as special tools. But, just as in many cases a multiple-spindle drilling-head will serve in the place of a multiple-spindle drilling-machine, a multiple-spindle milling-head attached to a standard machine can take the place of the special multiple-spindle milling-machine.

All the things mentioned with regard to milling can be found when visiting automotive shops, but they are at present rather the exception than the rule. Furthermore, to the extent that a study has been made of the requirements of milling, it has been applied mostly to the more important operations on the main pieces of the automobile, whereas progress along these lines has been slow for the less important operations and pieces. Nevertheless, taken as a whole, the less important operations and pieces require a large number of men and a great deal of equipment, and fully deserve the most careful attention.

Improvements Require Changes in Machine

Grinding operations do not lend themselves well to worthwhile improvements without making some change in the existing machine. This might be expected because the operator has no control over the tool. There is no way by which he can sharpen the tool to a preferred angle; nor can he improve on the lubrication or on the holding devices for tools or work except, perhaps, in the rarest instances. He may find that a certain material gives the best results with his grinding wheel but he will always be left more or less in the dark as to the hardness, for no two wheels are exactly the same.

On the other hand, grinding operations lend themselves probably to greater improvements than do any of the simple cutting operations. To mention one thing, I have found by actual test that a small difference in the wheel speed makes an enormous difference in the wear of the wheel. It was found that a carborundum wheel running at 5700 ft. per min. would remove 1.9 cu. in. of cast iron, when grinding cast-iron bushings, with 0.001 in. loss in diameter; whereas the same wheel, when running at a surface speed of 6000 ft. per min., would remove 5.7 cu. in. of cast iron. This little difference of 300 ft. per min. increased the output of the wheel exactly 200 per cent. Knowledge of these facts made it possible to prescribe a fixed number of passes over a given piece of work and made measuring with the micrometer unnecessary, except for an occasional test-piece. It was further found that to increase the speed 300 ft. on the other side of the 6000-ft. line caused the wheel to glaze and reduced the output. There was, then, a critical point in the speed of the wheel. Though it was found that the actual speed of the wheel should be very close to this critical point, it was also found that existing grinding-machines do not have the means of obtaining any desired speed; but this was overcome by driving the grinders by adjustable-speed motors and by providing the necessary safeguards so that a workman could not run the wheel at a dangerous speed, when replacing a worn small wheel with a new large one.

Though I do not wish to say that the difference in the performance of a wheel is always as great as it was found to be by the test mentioned, experience has shown that there is always a critical point for the speed of the wheel and that the best results with regard to uniformity of dimensions and lasting qualities of the wheel are obtained at or near this critical point. If advantage is to be taken of this condition, means must be provided for running a grinder at whatever speed may be necessary to produce the critical speed of the wheel used.

Wide-Face Wheels

Wide-face wheels are probably used to a larger extent in automotive shops than in those of any other industry, but this is not saying very much, because as a whole the merits and the practicability of wide-wheel grinding are not very well known. Wheels up to 8 in. in width have been successfully used, and to the best of my knowledge no reason exists that wider wheels should not be used, provided that they can be adequately supported. I have used stepped wheels and was able to control conditions without trouble. It seems that the use of wide wheels in grinding practice should be largely extended.

Grinding lends itself very well to the use of magazine feed. So far, magazine feeds have been confined mainly to centerless grinders, but in other industries automatic grinding-machines with magazine feed, using wide wheels, have been developed and are used very success-

fully. If possible, the wheel should be given a slight shaking-motion in the axial direction, when the end of the cross-feed or the in-feed has been reached. It is possible, however, to produce a good job without this end-motion, when shoulder work must be done and axial shake is not possible.

No apparent reason seems to exist that not more than one cylinder should be ground at one time, except that, at the present at least, no machine can perform this operation. At the present time opinion differs so greatly as to the best way of finishing cylinders that a drive for a multiple-spindle grinding-machine might not be justified. In connection with the different ways of finishing, I wish to state that I have succeeded in producing a very accurate size and a very hard and glossy surface in cast-iron bushings by running through the bushing a piece of hardened steel resembling somewhat a straight-fluted reamer with gentle taper, but having the ribs rounded instead of presenting cutting edges. About 0.0006 in. per inch of diameter was allowed for reduction. A similar method might be successful in finishing cylinders, though I do not wish to go on record as saying that it is bound to be successful. The lack of uniformity of cross-section in a cylinder might produce undesirable results. This method, furthermore, can be employed only when the cylinder to be burnished is open at both ends.

As has been said before, the scope of this paper does not allow me to go into all the operations that are common in the automobile factory, nor into detail regarding any one of them. I have aimed to give sufficient examples of a few operations to make it clear that substantial improvements can be made and that, at the present time at least, efforts in the direction of economy should be directed toward the small pieces and small operations, because these happen to be the field that has been least cultivated. This is a condition not at all peculiar to the automotive industry; it can be found in almost any shop. As it is much easier for the average man to recognize unsatisfactory conditions outside his home than inside, an illustration with regard to a shop that is not an automobile factory may not be out of place here.

On a recent visit to this factory, which is well known throughout this Country for its high-grade work and uptodate methods, I found that many of the chief operations, particularly on the larger pieces, were excellently taken care of. Operations that presented great difficulty had been studied thoroughly and the difficulties had been overcome in a most ingenious and satisfactory manner. On the other hand, in one department alone, 125 operators were found, all drilling small holes in small pieces with sensitive drills. Apparently the operation was too insignificant to attract the attention of the engineering department.

It is my opinion that, to a certain extent at least, the same condition prevails in the automotive industry, and that greater gains can be made in the field of small operations with less capital outlay than in the activities of other parts of the shop.

ADVANTAGES OF ELECTRIC TRUCKS

IN its own field, work of any kind that requires frequent starting and stopping, such as short city hauls and delivery routes, the electric truck is the most economical vehicle that can be obtained. The number of movements saved by the driver in a year on the average delivery routes because of greater ease in starting and stopping an electric truck as compared with a gasoline truck has been figured by one user as running well into the hundreds of thousands. The consequent saving in the driver's time and energy is an important item to any firm that has a large number of routes to be served and maintains a fleet of trucks.

The advantages accruing from the use of electric trucks on short-haul or frequent-stop routes may be briefly recapitulated as follows:

(1) The electric truck greatly reduces costs

(2) It is the fastest truck on short-haul or frequent-stop routes

(3) Its simplicity makes it easy to run and easy to repair

(4) It is rugged and reliable, seldom breaking-down on the road and becoming disabled less frequently than any other type of vehicle

(5) It lasts between two and three times as long as a gasoline truck

(6) It is clean, assuring immaculate sanitary conditions for the goods it conveys

(7) It is quiet

(8) It is odorless

(9) It can be stored at loading platform, saving garage space

(10) It uses power with the irreducible minimum of waste

(11) It has all the speed that is consistent with prudence in city running and power economy

(12) Employer's control of the speed is inherent in the truck

(13) Its tractive power is greatest in proportion to the horsepower used

(14) Its hazard from fire, accident and theft is lowest

(15) It costs less to run and maintain

It has been estimated that only 4 per cent of all city trucking is done by electric trucks. It has been demonstrated beyond a reasonable doubt that electric trucks are more economical, speedier and better adapted in many ways to more than three-quarters of all city service, namely, the 75 to 85 per cent of such service which involves short hauls or frequent stops.—President R. E. M. Cowie, American Railway Express Co.

GERMAN SYNDICATES

THE American Chamber of Commerce in Germany observes that the following statement of Dr. Felix Pinner is of interest to American economists, and especially to those who have maintained that industrial over-organization is harmful in normal times and disastrous in times of stress and emergency:

The net of cartels, syndicates, conventions and combines into which German industry and trade has spun itself during the inflation and through which combines of producers and middlemen favor one another and gain special profits, greatly hinders German business in its agility and its adjustment to new economic conditions and requirements. It makes each link lazy and indolent, increases cost of production, petrifies calculation and is out of place in a time when international competition requires greatest efforts and economy.

Future Problems of Motorbus Engineering

By A. F. Masury[1]

Automotive Transportation Meeting Paper *Illustrated with* Drawings

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

SUBSTANTIAL reduction of motorbus depreciation by materially increasing the useful life of the vehicle is an important problem now facing the automotive engineer. The author contrasts present motorbus life with that of street-cars; he finds a probable life of 4 or 5 years only for the former and 20 to 25 years for the average type of trolley-car. This, in the case of the motorbus, he says, is too short a period of usefulness and directly affects operating costs, since the increased cost of motorbus maintenance offsets its lower initial-cost.

Demand for maximum comfort, safety and speed from the public and for economical operation from the operators has renewed interest in the six-wheel motorbus and given its design an impetus, although present four-wheel motorbuses of 25 to 30-passenger capacity have, and will continue to have, a very definite field and will not become obsolete due to replacement by other types. However, the exact placement of the line of demarcation between the four and the six-wheel types is a problem. Specification of maximum vehicle-weight per inch of tire width will regulate motor vehicles most logically for highway conservation, in the author's opinion, other means being stated to be manifestly unfair, unscientific and detrimental to economic progress.

Design and location of the chassis units to permit adequate ground-clearance and low-hung floors is a perplexing matter. Assumptions of seating capacity, body dimensions and power needed come first; then, the determination of the wheelbase. For the six-wheel type, the last is either the distance between the front axle and the forward rear-axle or the distance between the front axle and a point midway between the two rear-axles; but the author leaves this question open, as well as that of the proper ratio between the wheelbase and the distance between the two rear-axles, except that these axles should be as close to each other as possible to reduce axle side-slip to the minimum. The spring-suspension should consist of the simplest spring combination that will provide maximum flexibility. Numerous spring-combinations are illustrated.

Two rear-axles permit smaller axle-units, provide increased ground-clearance, decrease over-all height and reduce individual unsprung-weight, according to the author. When the wheels of one axle roll over a bump, the rise of the sprung mass is only one-half that occasioned in the conventional design, but the time required is the same; therefore, the velocity of drop of the sprung mass is halved. Since the impact force is $F = \frac{1}{2} M V^2$, the body reaction and stresses induced in this type are but one-quarter of those felt in the single-rear-axle type and this fundamental advantage of the dual rear-axle produces the increased good riding-quality attained.

Other questions on which opinion is divided are whether to drive with only one of the two rear-axles, using the other as a load-carrying element, to drive through all four rear wheels, to transmit power through the gears of the first axle to the second or to divide the power equally between each of the axles by using a power differential. The maximum universal-joint angle permissible with any spring and drive arrangement is mentioned. One that will permit the axles to maintain a fixed relation one to the other eliminates the angularity of the short drive-shaft between each axle.

Skidding is practically eliminated when braking all four rear wheels of a six-wheel motorbus, even on wet, greasy, smooth pavement; therefore, it is questionable if brakes on the front wheels also are needed. As the size and weight increase, servo mechanism becomes necessary; the question then is whether to cause it to operate a drive-shaft brake in conjunction with front-wheel brakes or to cause it to apply the wheel brakes only, reserving the drive-shaft unit for emergencies.

Steering must remain easy, even though the wheelbase increases. This may necessitate center-point steering, possibly having the axis of the king-pin in the plane of the wheel. The bore-and-stroke ratio of the engine must be chosen to comply with the accepted characteristics of a motorbus engine, but must also combine the maximum crankcase-front-axle clearance with a low over-all-height. The author favors the four-cylinder rather than the six-cylinder engine for this service.

Frame construction presents the problem of striking a compromise between relative rigidity and excessive weight. A flexible frame demands a flexible body. The choice lies with the flexible type of motorbus chassis and body or the super-rigid assembly. Other problems relate to ventilation, heating, freedom from road dust, prevention of exhaust gases and engine compartment vapors from entering the body and the elimination of noise. Safety appliances that will apply the brakes automatically in case of accidental loss of control by the driver are suggested.

Greater manufacturing cost, increase of total weight and higher transmission-losses constitute the price that must be paid for vehicles employing more than four wheels, but these may be offset by the increase in good riding-quality, and by the greater capacity, tire-mileage and fuel-economy obtained. Future development also depends largely upon the progress made in road design and expansion of the areas traversed by suitable highways.

HOW to increase the useful life of a motorbus materially, so that its depreciation can be substantially reduced, is one of the most important problems before the automotive engineer today. We know that the average type of trolley-car has a life of 20 to 25 years. While we do not know the corresponding figure for the motorbus, we have at our disposition statistical data that permit us to arrive at rather amazing conclusions. The figures show the average daily

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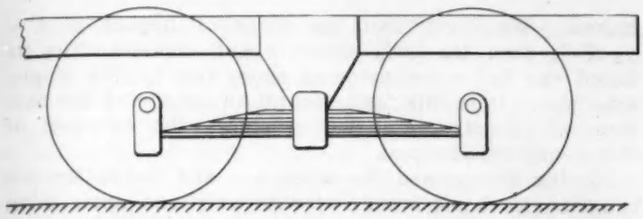

FIG. 1—A SPRING-SUSPENSION REQUIRING TORQUE-TUBES OR ARMS
This Arrangement Is Simply an Inverted Semi-Elliptic Spring Clamped to the Frame at Its Center and Having the Ends Connected to the Axles. This Construction Localizes the Loads on the Frame and Produces High Spring-Stresses when Both Wheels Roll over Equal Inequalities Simultaneously

mileage covered by motorbuses to be 208 miles each, representing a continuous operation of 16 hr. per day at an average speed of 13 m.p.h. Making an allowance of 30 days for yearly overhaul and maintenance, the mileage covered per unit is approximately 70,000 miles per year. If we assume that a mileage of 300,000 to 350,000 miles is sufficient to send a motorbus to the scrapheap, and many of them arrived there before reaching this figure, we are faced with a useful motorbus life of 4 to 5 years.

This rather short period of usefulness is an important item that directly affects operating costs. One may say that the initial investment is considerably less for the motorbus, but this is offset by the increased cost of maintenance. Motorbus engineering has not yet reached the point where stabilized designs can be standardized and improved rather than changed. This undoubtedly is due to the exacting demands of the growing riding

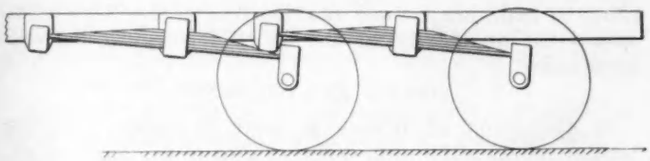

FIG. 2—A DUAL FULL-CANTILEVER SUSPENSION
While the Load Is Distributed More Evenly on the Frame in This Construction, It Is Difficult To Realize on Account of the Clearances Required

public for maximum comfort, safety and speed, together with the economical operation demanded by operators. This natural tendency for better riding-quality has renewed the impetus of the six-wheel motorbus. It does not mean, however, that the present four-wheel motorbuses, having seating capacities of 25 to 30 passengers, will be displaced. This will never be the case, as there is a very definite need for this type of motor vehicle, and always will be. To supplant it with a larger carrier would be against commonsense economics.

THE SIX-WHEEL MOTORBUS

To state with exactness just where the line of demarcation between four-wheel and six-wheel motorbuses belongs is not within the scope of this paper. The point to be taken into consideration is the tendency of legislation, especially regarding total vehicle-weights permissible. The adoption of a specified maximum weight per inch of tire width is, in my estimation, the most logical way to regulate motor vehicles from the viewpoint of highway conservation. To do so in any other manner would be manifestly unfair, unscientific and detrimental to economic progress.

The idea of the six-wheel or multi-wheel principle is not new, but the experimental data obtained and the practical work done so far are not sufficient to formulate definite rules as to what the specifications should be. As far back as 1912, the company with which I am associated built an experimental six-wheel vehicle which was called the Dow Dual-Wheel. It had two rear driving-axles, the first one being driven by a chain from the jackshaft and the second rear-axle being driven from the first one by another chain. To reduce the distance between each driving-axle, the rear one was made with a wider tread, which permitted the wheels to overlap each other. The suspension consisted of a semi-elliptic spring clamped on the middle of a beam connecting each axle on each side. The rear ends of the springs were shackled to an additional platform-spring.

Are the six and eight-wheel vehicles, that have been built recently and are operating at present, practical applications or just engineering dreams? From all appear-

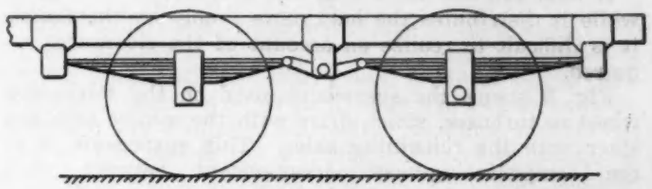

FIG. 3—SPRING-SUSPENSION USED ON THE PARIS SIX-WHEEL BUSES
These Vehicles Are Driven by the Middle Axle and the Steering Is Done by the Other Two. A Compensating-Beam Arrangement Is Located between Each Spring and the Suspension Requires a Fixed Distance between Each Rear-Axle, Thus Necessitating Steering More Than Two Wheels

ances they are proving their economic worth and filling specific needs. Essentially, they must be large carriers.

PROBLEMS OF LARGE MOTORBUS DESIGN

One of the most perturbing problems of large motorbus design is how to design and locate the various chassis units so as to obtain sufficient ground-clearance as well as low and level floor-height. Having assumed the seating capacity of the motorbus body and primarily determined its dimensions, as well as the power necessary to obtain a standard of performance, the next step in line is determining the wheelbase. In the case of the six-wheel type, is it the distance between the front axle and the forward rear-axle, or the distance between the front axle and a point midway between the rear axles? What is the proper ratio between the wheelbase and the distance between the rear axles? Of course, from an easy-steering standpoint, the rear axles should be as close together as possible to reduce axle side-slip to the minimum; but, on the other hand, they must be suspended, and this brings us to the mean problem of the spring-suspension. The simplest spring-combination to obtain maximum flexibility is the best, of course.

The suspension shown in Fig. 1 is nothing more than an inverted semi-elliptic spring clamped to the frame at

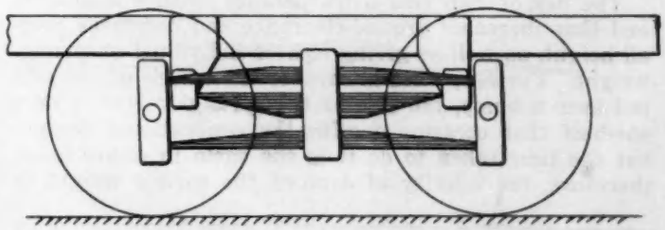

FIG. 4—SYSTEM OF SPRING-SUSPENSION ADOPTED BY THE CALIFORNIA TRACTION CO.
Six Springs, Three on Each Side, Are Used in This Design. Two of the Springs Are of the Inverted Semi-Elliptic Type and Are Pivoted Individually at the Center and Bolted Directly to the Axles at Their Ends. This Assembly Is Connected to the Frame in the Conventional Manner by a Third Semi-Elliptic Spring That Is Shorter and Stiffer Than the Other Two

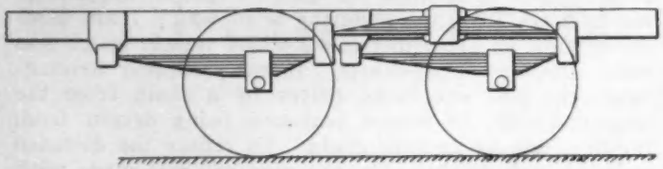

FIG. 5—ANOTHER COMPENSATED-ACTION ARRANGEMENT
This Layout Also Makes Use of the Three-Point Frame-Suspension

the middle and having its ends connected to the axles. This construction localizes the loads on the frame and produces high spring-stresses when both wheels roll over equal irregularities simultaneously. Torque members are also required to take the driving and the braking efforts.

A dual full-cantilever suspension is shown in Fig. 2; while it distributes the load more evenly on the frame, it is difficult to realize on account of the clearances required.

Fig. 3 shows the suspension used on the Paris six-wheel motorbuses, which drive with the middle axle and steer with the remaining axles. This suspension is of the compensating-beam arrangement between each spring, and requires a fixed distance between each rear-axle, thus necessitating the steering of more than two wheels. However, it is simple and is extremely flexible.

The system adopted by the California Transit Co. is shown in Fig. 4. It is composed of six springs, three on each side, two inverted semi-elliptic springs individually pivoted at their centers and directly bolted to the axles at their ends. A third semi-elliptic spring, shorter and stiffer, connects this assembly to the frame in the conventional manner.

Fig. 5 is another compensated-action arrangement with three-point frame-suspension.

The spring layout shown in Fig. 6 is another conception of the compensating-beam principle.

Fig. 7 illustrates what might be termed the X spring-construction; it consists of a short inverted semi-elliptic spring connected to each axle and clamped or pivoted, as may be deemed advisable according to the conditions, to a longer conventional semi-elliptic spring. This construction seems to provide good flexibility as well as compactness.

Fig. 8 shows another method of equalization of the spring-load by using a cable and a sheave.

These are but a few of the possible ideas that can be developed to obtain the required motorbus suspension, which should have the minimum of unsprung weight, small encumberment and excellent flexibility coupled with simplicity.

ADVANTAGES OF TWO REAR-AXLES

The use of two rear-axles permits smaller axle-units and thus increases ground-clearance and decreases overall height, as well as giving lighter individual unsprung-weight. Further, when a wheel or the wheels of one axle roll over a bump, the rise of the sprung weight is only one-half that occasioned with the conventional design, but the time taken to do it is the same in either case; therefore, the velocity of drop of the sprung weight is halved. We know that the force of impact is $F = \frac{1}{2} MV^2$; then the body reaction and stresses thus induced are but one-quarter of those felt by the single-axle type. It is this fundamental advantage of the dual rear-axle construction that produces the increase of riding-quality obtained.

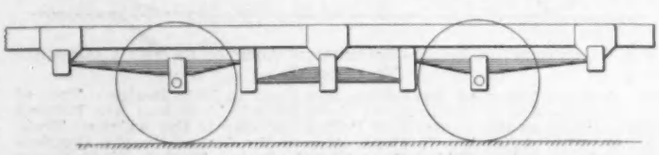

FIG. 6—ANOTHER CONCEPTION OF THE COMPENSATING BEAM PRINCIPLE

Having determined the wheelbase and the spring arrangement, should we drive with only one axle, using the other as a load-carrying element? Or should we drive through all four wheels? Here, again, opinions are divided. Should the power be transmitted through the gears of the first axle to the second? Or should it be divided equally between each axle by a power differential? Unquestionably, the latter is a more expensive construction and perhaps is limited to the larger vehicles, but it possesses advantages, as in the case of different tire-diameters on account of wear or other causes. By differentiating the power, driving members can be made lighter. A further improvement might include a power differential-lock to prevent slipping so that, at all times, one-half of the weight on the rear axles times the coefficient of friction of the tires at the ground can be available for traction.

To drive but one axle is commendable from the viewpoint of simplicity, but it reduces the tractive effort available. In conjunction with a flexible spring-layout, it is likely that, occasionally, the driving-wheels will leave the road and cause engine racing, especially when rolling over what are termed "washboard" roads.

Before leaving this subject, mention must be made of the maximum universal-joint angle permissible with any spring and drive arrangement. One that will permit the axles to maintain a fixed relation one to the other eliminates the angularity of the short drive-shaft between each axle.

BRAKES AND STEERING

A discussion of brakes is next in order. Having brakes on all four rear-wheels, should we have front-wheel brakes also? That may be advisable, but is this complication offset by the gain? If the center of gravity is low, the shifting of weight toward the front when braking will be decreased. Further, tests have proved that skidding is practically eliminated when braking on the four rear-wheels of a six-wheel vehicle, even on wet-and-greasy smooth-pavement. The grip on the road is almost perfect. To obtain uniform braking, the point of power application should be at the center of the rocking plane of the suspension.

As the size and the weight of motorbuses increase, human power becomes inadequate to apply the brakes efficiently and recourse must be made to the servo mechanism. This brings up another question: Should the servo mechanism operate a drive-shaft brake in conjunction with front-wheel brakes, or should it apply the wheel brakes only, reserving the drive-shaft unit for emergencies? Of course, the shaft brake equalizes the braking effort, which is multiplied by the gear ratio.

As the wheelbase increases, steering must remain easy. This may necessitate center-point steering, possibly having the axis of the king-pin in the plane of the wheel. To do this and have front-wheel brakes at the same time on a large vehicle is a problem requiring considerable engineering skill and involving scientific research, especially when it is considered that standard disc-wheels have an outside diameter of 20 in.

ENGINE AND CHASSIS

In designing the engine, a bore-and-stroke ratio must be chosen that will not only provide the characteristics

a motorbus engine should have, but also combine maximum clearance between the crankcase and the front axle, with low over-all height.

We have heard a great deal recently about six-cylinder engines for motorbus work. Is this multiplicity of cylinders the ultimate solution? I am rather inclined to believe that it is not a matter of number of cylinders but rather one of performance. Strange as it may seem, a six-cylinder engine is cheaper to build than is a good four-cylinder engine. It is a human trait always to choose the path of least resistance. But, from operating and maintenance viewpoints, the four-cylinder engine is far superior. A well-designed four-cylinder engine can be made to equal the performance of the ordinary six-cylinder engine. It has less length and, being simpler, is easier to maintain.

Before leaving the chassis, let us consider another important unit, the frame. In large sizes and for economy

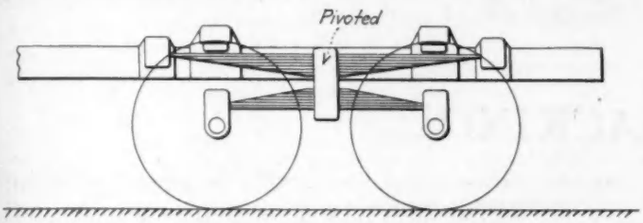

FIG. 7—THE X-TYPE SPRING-SUSPENSION

This Construction Consists of a Short Inverted Semi-Elliptic Spring Connected to Each Axle and Clamped or Pivoted, as Conditions May Render Advisable, to a Longer Conventional Semi-Elliptic Spring

in production, we may be forced to build the frame in two sections. If so, where should it be split? The loading and bending-moment diagrams shown in Fig. 9 seem to indicate that the splitting-line should be just ahead of the forward rear-axle.

Again we are facing an old controversy. Should the frame be built to be flexible, or to provide the utmost rigidity possible? In the first place, complete rigidity is mythical. The case is one in which we must strike a compromise between relative rigidity and excessive weight.

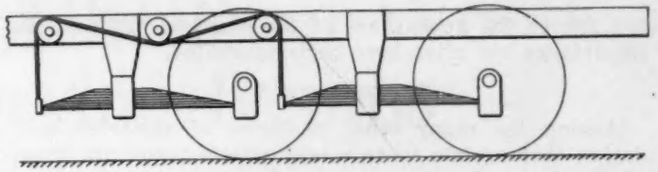

FIG. 8—A FORM OF SPRING EQUALIZATION USING A CABLE AND A SHEAVE

This Principle of Weight Equalization Is Not Limited in Its Application to the Arrangement Shown Above. The Ends of the Flexible Member Can Be Attached Either to Appropriate Points in the Spring-Suspension or Directly to the Axles. The Regulating Sheave Can Be Omitted or It Can Be Carried on a Rigid Mounting Provided with Means for Varying the Position of the Sheave on the Frame So as To Permit the Varying of the Height of the Frame above the Axles, or the Regulating Sheave Can Be Suspended from the Frame on a Spring-Mounting with or without Provision for Varying Its Position on the Frame. The Spring-Mounting of the Regulating Sheave Would Be Provided To Reduce Shocks on the Flexible Member

Body design and frame design are directly linked. If we are to have a flexible frame, we must also build a flexible body. On the other hand, if we choose a relatively stiff frame, a super-rigid body will be necessary to reinforce the complete assembly. Perhaps a combination of the two is the solution. Duralumin might be used advantageously as a body material, thus combining strength with lightness.

Looking at it from another angle, should we have a frame? We seem to have been guided in the past by motor-truck practice. A frame is necessary in this case on account of the variety of bodies suitable for different kinds of work. But, in the case of the motorbus, we have to deal almost exclusively with closed bodies of box-like structure. Why not build the assembly along lines somewhat similar to those adopted by the Lancia company for its smaller passenger-cars? Let us go even further and build the body in sections to be joined together, thus simplifying service problems in cases of accident.

Thus, we see two distinct ways opened before us, the flexible type of motorbus chassis and body, and the super-rigid assembly. In other words, should the motor vehicle be designed as a simple beam or on the trussed-bridge principle? In working out this problem, let us

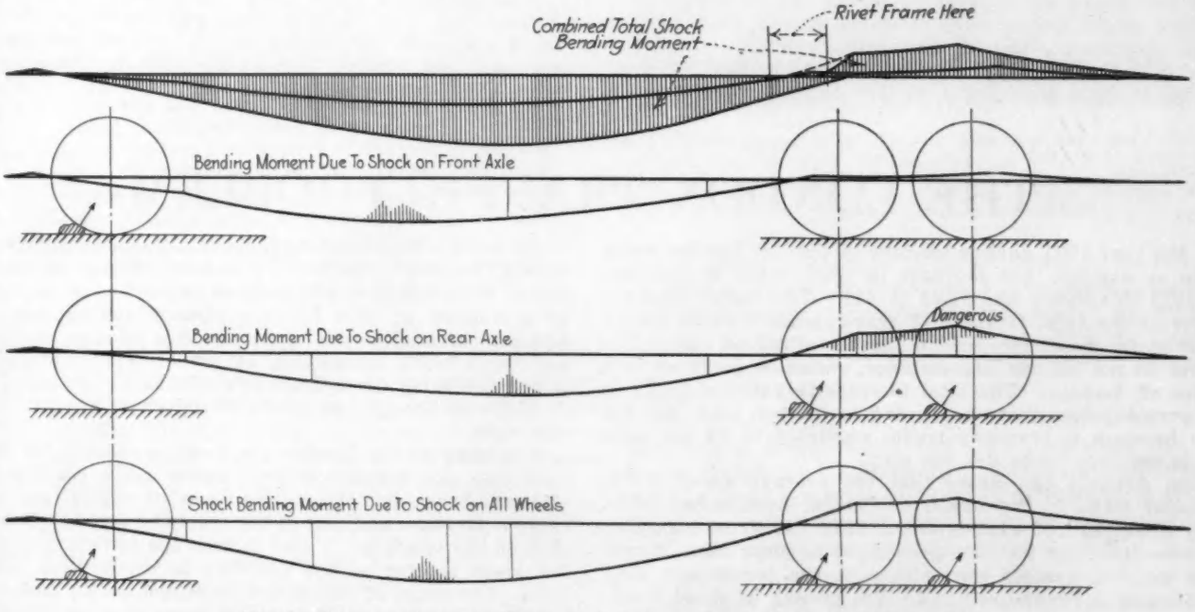
Combined Total Shock Bending Moment
Rivet Frame Here
Bending Moment Due To Shock on Front Axle
Bending Moment Due To Shock on Rear Axle
Dangerous
Shock Bending Moment Due To Shock on All Wheels

FIG. 9—DIAGRAM SHOWING WHERE A TWO-SECTION FRAME SHOULD BE SPLIT

The Loading and Bending-Moment Diagrams Reproduced Indicate That When the Size of the Frame or Economy in Production Necessitates the Building of the Frame in Two Sections, the Splitting-Line Should Be Directly in Front of the Forward Rear-Axle

not forget the appearance of the finished product; its importance has often been underestimated.

Other Problems

Among the many other problems of motorbus-body design that remain to be solved satisfactorily are those of ventilation, heating, freedom from road dust, preventive methods that are needed to eliminate the exhaust gases as well as engine-compartment vapors from reaching the body, and the elimination of noise in general.

What the ultimate motorbus will be is a matter of conjecture. The combination of engineering ideas, based upon sound fundamental principles and seasoned with plenty of logic, is at best but a compromise that will produce results which must win the approval of the riding public in the future.

To be successful in operation, any common-carrier must be safe. We have in trolley and subway work what is known as the "dead-man" control. Cannot this be applied in motorbus work by devising safety appliances which will apply the brakes automatically in case of accidental loss of control by the driver?

Upon the solution of all these questions rests the future of the motorbus. Whether the ultimate vehicle will have four, six or eight wheels, I hardly dare prophesy. The greater manufacturing cost, the increase in total dead-weight and the higher transmission-losses constitute the price to be paid for more than four wheels. This may be offset by the increase in riding-quality, and the greater capacity, tire-mileage and fuel-economy obtained. Future experiments may show a reduction in maintenance also.

Let us not forget that the inherent flexibility of the motorbus is its greatest asset, and that its future development is dependent in large measure upon progress in highway improvement and in road design. The success of motorbus transportation will be proportional to the extension of good roads.

OIL CRACKING

THE distillation of oil, crude or refined, is always accompanied by partial decomposition, even when performed at atmospheric pressure and when superheating is avoided. That is one of the chief reasons why the nature of natural oils remains obscure. Distillation at higher pressures is more destructive. And the kinetics of this pyrolysis are still but little understood, even when we start from simple hydrocarbons. The destructive distillation of oil for the purpose of breaking down high-molecular complexes into compounds of lower molecular weight and of higher value may be performed in the vapor or in the liquid phase.

The two processes have developed simultaneously, but the liquid phase predominates at present. In 1923, nearly 21 per cent of the gasoline used in the United States was produced by cracking, mainly in the liquid phase, and the art of cracking is now being standardized, as A. E. Dunstan and R. Pilkethley stated in a paper on Recent Development in the Art of Cracking, read before the Institution of Petroleum Technologists.

If it were possible, each separate compound should be cracked at the temperature at which decomposition sets in; when that temperature was gradually exceeded, however, the quantity of spirit obtained was almost doubled by every further increase of 10 deg. cent. (18 deg. fahr.), an interesting observation in accordance with the general rule of the rate of chemical reactions.

Bergius originally studied the formation of coal and produced a kind of bituminous coal from cellulose in his autoclave for high temperatures and pressures. Afterward he converted inferior coal into oil by sealing it up with water and hydrogen, and also obtained motor spirit by spraying heavy oil together with hydrogen into his autoclave, initially heated to 400 deg. cent. (752 deg. fahr.); the reaction proceeds endothermically, and the pressure may rise to 300 atmospheres. Such reactions may take place even in nitrogen atmospheres, the breakdown of some of the hydrocarbons or of the water supplying the necessary hydrogen. Oil hydrogenation is carried out in Rheinan on a fairly large scale.

The Bergius process is said to proceed without formation of coke. Dr. Thole has remarked that the coke in cracking processes is a secondary decomposition product of a certain viscous tarry matter. That point will be made the object of a further investigation.

Cracked spirits differ from straight-run spirits, and the conventional, now standardized, gasoline-tests are not directly applicable to cracked spirits, or their results are at any rate not directly comparable with ordinary gasoline-tests.—*Engineering* (London).

THE LONDON TRAFFIC PROBLEM

IN the year 1905, each inhabitant of Greater London made, on an average, 188 journeys in tram, train or omnibus. By 1923 this figure had risen to 421. This figure does not represent the total increase of travel, since it takes no account of the great increase in the use of motor cars. The figures do not include long-distance, main-line journeys into, or out of, London. The total increase in railroad traffic in the period taken above amounted to 60 per cent, but the total increase in tramway traffic amounted to 94 per cent, and in omnibus traffic 288 per cent.

Lord Ashfield has stated that the average speed of the vehicular traffic in the streets of Central London has fallen today to one-half of what it was in 1919. If street transport throttles itself by its own growth, it is clear that it will cease to be a greater convenience to the public and they will forsake it for the railroad. The growth in street traffic is interfering with business generally, and, although the omnibus passenger, who has an alternative method of travel by tube which he does not use, has no serious grievance about the slowness of street traffic; other street users have.

Sir Lynden Macassey suggests that the present difficulty in Central London be assisted by decentralization and the moving of large companies to the outer suburbs. A fair amount of movement of this kind is already taking place. Sir Lynden referred to the enormous cost of any attempts to deal with traffic congestion by street widening and mentioned favorably Lord Montagu's scheme for overhead roads, to which he thought we would be driven at no very far distant date.

According to Sir Lynden the average receipt per vehicle-mile does not greatly differ between train coaches, trams and omnibuses, but the railroad cost of capital per mile of route is 20 times and that of the tramway three or four times that of the omnibus. These figures are sufficient to explain the great success of the omnibus in competition with the tram. The tram, of course, developed before the motor omnibus, and naturally all the capital invested in it simply cannot be written off, but it is clear that no case exists for any considerable increase in tramway mileage.—*Engineering* (London).

Causes of Surface Checks in Wood in Varnish-Drying Rooms

By HARRY D. TIEMANN[1]

PRODUCTION MEETING PAPER *Illustrated with* PHOTOGRAPHS AND DRAWINGS

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

PECULIARLY complex in its cellular structure, wood is subject to deformation that accompanies changes in its moisture content which is neither uniform nor isometric. Generally, deformation is about fifty times as great in the radial direction of the log as longitudinally, and about twice as great circumferentially as radially; so, when moisture changes occur due to changes in the degree of humidity of the surrounding air, the behavior of wood is very uncertain. Conditions are complicated further by the manner in which drying takes place.

A description is given of how water is contained in wood, including details of wood structure, and the action of moisture in causing swelling and subsequent shrinkage is discussed. The fiber-saturation point marks the limit to the amount of moisture that can enter between the fibrils, at which limit swelling ceases. It is determined by making endwise compression tests on a series of small blocks of the wood, as its drying proceeds. Water is, therefore, contained in wood as hygroscopic moisture adsorbed in the cell walls and as free-water occurring in the capillary spaces, with the fiber-saturation point as the division line between the two conditions.

In describing how wood dries, "set" and "casehardening" are explained, since the problem of the dry-kiln engineer is to control these drying stresses so that the wood shall suffer no serious injury. When drying a green stick of wood in air or in the kiln, surface checks will at first tend to open up as a result of the tensile stress in the outer surface. But when the reversal of stress takes place as the drying proceeds, these surface checks will close up again and may even pinch tightly together by reason of the compression of the "set" surface. They may become invisible, even when the lumber is planed. What happens when dry wood having these incipient but invisible surface checks is placed in a varnish-drying room that has a high relative humidity and a high temperature is set forth, and three specific causes of varnish-drying trouble are stated.

WOOD, like many other organic materials, is highly hygroscopic; that is, it will absorb or lose moisture according to the degree of humidity of the surrounding air and this is accompanied by swelling or by shrinkage. On account of the peculiarly complex cellular structure of wood, the deformation accompanying changes in moisture content is neither uniform nor isometric. As a general rule it is about fifty times as great in the radial direction of the log as longitudinally, and about twice as great circumferentially as radially. These relationships may, however, become greatly modified in places by changes in the structure of the cell walls. On the lower sides of branches, for example, cells having very thick walls and with sharply spiral structure are usually formed. This peculiar structure is known as "compression wood." It sometimes occurs also in the trunk of the tree.

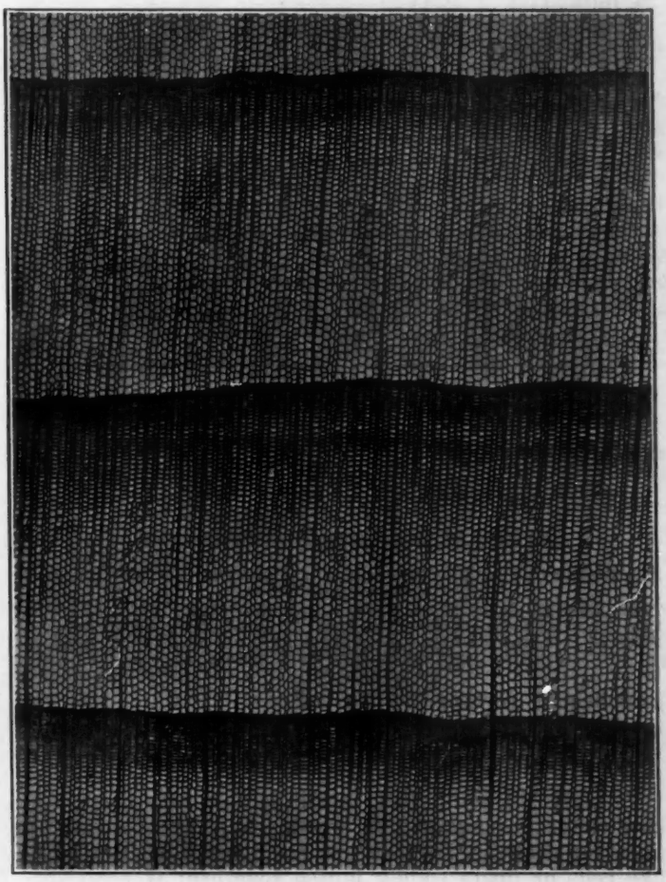

FIG. 1—CROSS-SECTION OF PIECE OF WESTERN RED-CEDAR MAGNIFIED 30 DIAMETERS, SHOWING TYPICAL CELLULAR STRUCTURE IN SOFTWOODS
Note the Honeycomb Like Appearance. Two Complete Annual-Rings Are Shown. The Narrow Medullary Rays Are Seen Running at Right Angles to the Rings

The longitudinal shrinkage of compression wood is abnormally large, sometimes even exceeding its transverse shrinkage. Moreover, it frequently happens that shrinkage in the same piece of normal wood in the same direction varies at different portions. Such conditions, inevitably producing severe stresses within the wood when it dries below its fiber-saturation point, are pointed out to show how uncertain the behavior of wood is when moisture changes occur through changes in the degree of humidity of the surrounding air. Conditions are

[1] Dry kiln expert, Forest Products Laboratory, Madison, Wis.

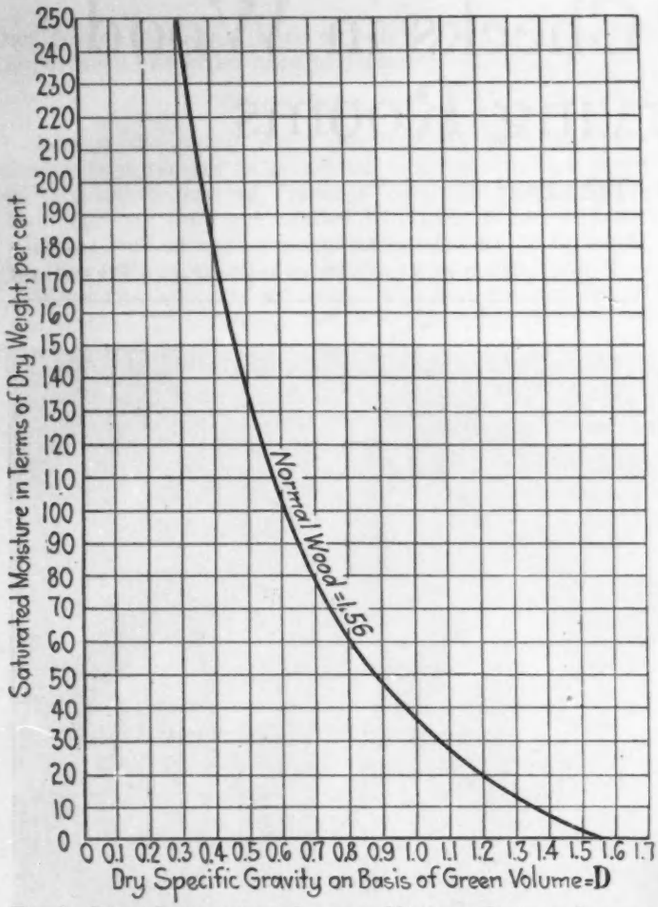

FIG. 2—CURVE SHOWING THE LIMIT OF MOISTURE CONTENT POSSIBLE IN A PIECE OF WOOD
This Chart Is Based upon Various Specific-Gravity Values for the Dry Wood and the Assumption That All Air-Spaces Are Filled. A Piece of Oak, for Example, May Have as Much as 120 Per Cent of Its Dry Weight as Moisture

complicated further by the manner in which drying takes place.

HOW WATER IS CONTAINED IN WOOD

To make the point clear, it will be necessary to explain how water is contained in wood. A piece of cedar or pine, for example, is made up of a number of long hair-like cells or fibers solidly united together; if cross-sectioned, the structure will resemble very much that of a honeycomb, as shown in Fig. 1. The fibers are joined end to end with long tapering splices. Each cell is completely closed, but the walls are perforated, at the splices especially, by many minute perforations or "pits." The pits are so small that, when wet, they are impervious to air; water, however, can seep through. The structural portion of the walls of the fibers is composed of cellulose, much the same as in cotton; but, in wood, the cellulose framework is intimately impregnated with other substances that form various kinds of "ligno-cellulose." The walls themselves are built up of minute spirally wound threads or fibrils in somewhat the same manner as in a cord tire. What the ultimate structure is beyond this, is unknown, since the fibrils are at the limit of microscopic observation. We know, however, that the cellulose molecule is large and complex, and probably one of the largest among the colloids.

I have used the illustration of a honeycomb as representing the microscopic structure of cedar or pine for the sake of simplicity, but the wood in reality is much more complicated. In addition to the vertical cells or fibers, *tracheids*, there are numerous horizontal bundles of very small cells interspersed between the vertical ones, to which they are closely united. These are the "medullary rays," and are arranged in the trunk radially somewhat like the spokes of a wheel. The minute bundles are flat, shaped like a two-edged sword and placed edgewise. In pine, there are also occasional small tubular openings between the cells, called resin ducts. In all hardwoods, and even in many of the conifers such as fir and hemlock, resin ducts are lacking. Moreover, in the case of hardwoods, as oak for example, in addition to the vertical fibers and horizontal medullary rays there are many tubular vertical openings of various sizes called "vessels" or "pores." In some species, as in red oak, these vessels are open tubes; in others, as in white oak, they are completely obstructed by small balloon-like cells called "tyloses." Hardwoods are therefore designated as "porous," and softwoods as "non-porous." For the purpose of this paper, however, we need not concern ourselves further with details as to the complicated microscopic structures of different species. For this the reader is referred to Chapter II of one of my books,[2] or to botanical works on the microscopic structure of wood.

HOW MOISTURE ACTION CAUSES SWELLING AND SHRINKING

Just how moisture action causes swelling and subsequent shrinking of wood is hypothetical, but all things point to the probability that the characteristic effects

FIG. 3—COLLAPSE OF THE CELLS OF WESTERN RED-CEDAR PRODUCED BY REMOVAL OF FREE-WATER FROM COMPLETELY SATURATED CELLS IN DRYING
Compare with Fig. 1, Which Shows the Same Material Without Collapse, at the Same Magnification, 30 Diameters

[2] See Kiln Drying of Lumber.

are due to moisture entering in *between the fibrils* of which the cells are composed, by virtue of an attraction called adsorption. As the molecules of water are adsorbed from the vapor in the air, the fibrils are probably pushed apart, thus causing swelling. Since the fibrils are arranged in a very steep spiral, normally at an angle of about 23 deg. with the longitudinal axis of the cell, it is evident that the swelling or shrinkage *across* a piece of wood would be much greater than that lengthwise.[3] The fibril-adsorption hypothesis also explains well the great lengthwise shrinkage in "compression wood," or *rotholz*, since the angle is much larger in this abnormal formation and often exceeds 45 deg.

There appears to be a definite limit to the amount of moisture which can enter between the fibrils, at which limit swelling ceases. This I have designated the "fiber-saturation point," in my article on the Effect of Moisture on the Strength and Stiffness of Wood[4]. Beyond that point the water merely enters the small cell cavities as

FIG. 4—COLLAPSE OF A 1-IN. BOARD OF WESTERN RED-CEDAR
This Photograph Shows Clearly the Effect of Removing the Water Contained in a Piece of Wood. When Green This Board Had a Rectangular Cross-Section

a liquid in capillary spaces, and exerts no further effect on the swelling or strength. The fiber-saturation point occurs at a moisture content of from 22 to 32 per cent of the dry weight of the wood, varying with different species and averaging around 25 or 26 per cent. This is covered in an article entitled The Strength of Wood as Influenced by Moisture.[5]

According to this hypothesis of hygroscopicity, or moisture absorption, one naturally would expect dry wood to be very much stronger and stiffer than green and, furthermore, that the reduction in strength as the wood absorbs moisture would suddenly cease at the fiber-saturation point. In fact, that is exactly what happens. A piece

[3] See Microscopical Features of the Mechanical Strains in Timber and the Bearing of These on the Structure of the Cell Wall in Plants by W. Robinson, *Philosophical Transactions of the Royal Society of London*, Series B, vol. 210; also Determiners of Cellulose Structure as Seen in the Cell Walls of Cotton Hairs, by W. L. Balls, *Proceedings of the Royal Society of London*, Series B, vol. 95; also Further Observations on Cell Wall Structure as Seen in Cotton Hairs, by W. L. Balls and H. A. Hancock, *Proceedings of the Royal Society of London*, Series B, vol. 93; also Uber der Innern Bau der Vegetabilischen Zellen Membranen, by Carl Nägeli. *Sitzungsberichte der Akademie der Wissenschaften zu München*, vol 1, p. 282 and vol. 2, p. 114.

[4] See Forest Service Bulletin No. 70.

[5] See Forest Service Circular No. 108, p. 11.

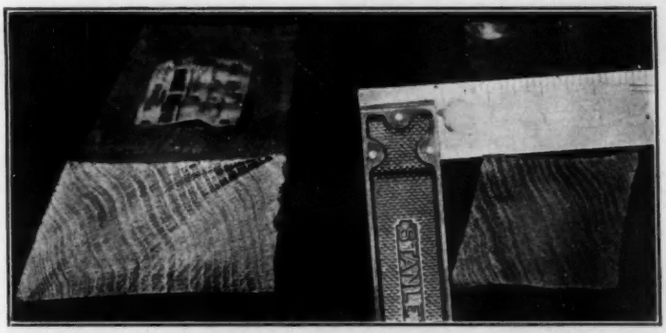

FIG. 5—ANOTHER EXAMPLE OF THE COLLAPSE THAT FOLLOWS THE REMOVAL OF WATER FROM A PIECE OF WOOD
Like the Board Shown in Fig. 4, This Piece of Swamp-Grown Oak Wagon-Stock Was Rectangular in Cross-Section when Green

of perfectly dry spruce, for example, will support in direct compression along the fibers four times the load which a green piece will withstand, and the failure occurs suddenly and is sharply defined; whereas, in the green material, it takes place gradually by a sort of bending of the fibers. Indeed, the most accurate method of determining the fiber-saturation point is by means of endwise compression tests on a series of small blocks of wood as the drying proceeds. At first, no change in strength is occasioned by uniform removal of moisture; then, suddenly, the strength begins to increase when the moisture content goes down past the critical value.

HYGROSCOPIC MOISTURE AND FREE-WATER

Water is thus contained in wood in two forms; as *hygroscopic moisture* adsorbed in the cell walls, and as *free-water* occurring in the capillary spaces, with the fiber-saturation point as the division line between the two conditions. Free-water can exist in wood to the point where all the internal cavities are filled completely. The curve in Fig. 2 indicates the total amounts of water which woods of different dry specific-gravities can contain. A piece of oak, for example, may have as much as 120 per cent of its dry weight as moisture.

Liquids other than water have a similar effect on the dimensional changes in wood. Alcohol produces very nearly as much swelling as water, and acts more rapidly even than hot water. Benzol swells wood appreciably, but not nearly so much as water. Gasoline produces a barely perceptible effect. Water-freed turpentine, strange to say, has no effect of swelling the wood. My experiments with these liquids were carried out on maple, basswood and white pine. Like turpentine, linseed oil probably has no effect other than that produced by the moisture which it may have entrained.

COLLAPSE

From the foregoing discussion it naturally would be inferred that, in drying a piece of wood, no deformation would take place until all the free-water had evaporated from the cell cavities and the cell walls began to dry out.

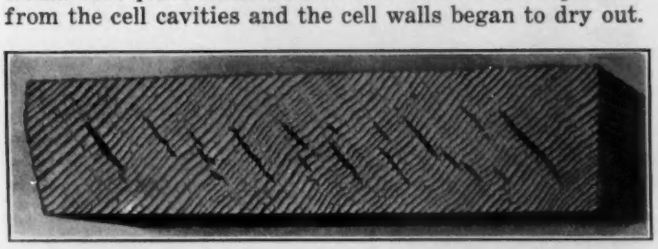

FIG. 6—HONEYCOMBING DUE TO SEVERE CASEHARDENING IN DOUGLAS-FIR PLANK
Note the Absence of Any Surface-Checks and That the Honeycombing Is Invisible to Outward Inspection

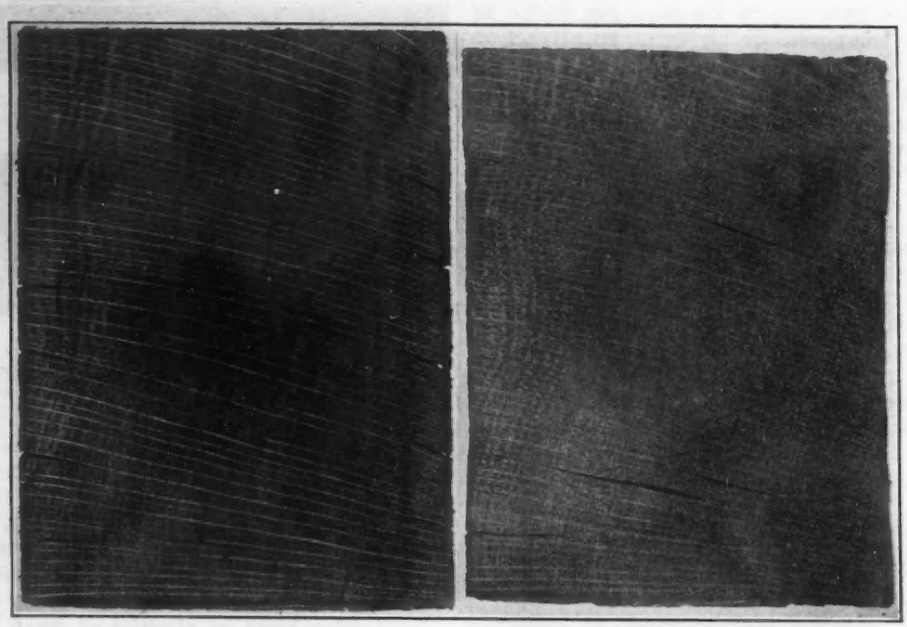

FIG. 8—HOW HONEYCOMBING SUCCEEDS SURFACE CHECKING AS THE DRYING PROCESS CONTINUES
The View at the Left Shows the Surface Checking Produced in an Oak Beam During the First Stage of Drying. The Tendency To Shrink Is Resisted by the Wet Interior. The Dark Area Represents Free-Water. A Section from the Same Beam at a Later Stage of Drying Is Shown at the Right. The Reversal of the Stresses Due to the Further Removal of the Free-Water Is Apparent from the Closing of Most of the Surface Checks and the Development of Honeycombing on the Inside

While this conclusion is correct so far as the cell walls themselves are concerned, it does not always apply to the wood as a whole. In many of the species more difficult to dry, such as swamp-grown oak or lowland western red-cedar, a pseudo-shrinkage or sinking in of the block as a whole occurs upon removal of the free-water, provided the cells are completely filled to start with. I have designated this phenomenon as "collapse." The effect is produced by a deformation of the cells or a collapse of the side walls, like that of a rubber tube that has been filled with water, closed at one end and the water drawn out from the other. The cell membranes are permeable to water; but, so long as they remain wet, they are resistant to air. Consequently, as the water passes out, an internal tension or cohesion is established which draws the walls together, as shown in Fig. 3. This is very distinct from true shrinkage, and occurs as soon as the free-water begins to be extracted. If, however, drying proceeds so slowly that air can enter the cells to replace the water by solution in it, collapse is avoided; and it only occurs when the cells are full to start with. This difficulty is very serious in some of the woods grown in damp ground, as shown in Figs. 4 and 5. Upland species are, in general, free from it.

[6] See *Journal of the Franklin Institute*, July, 1919.

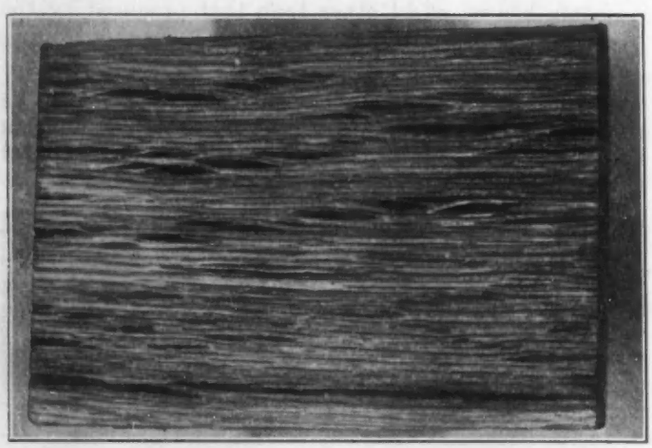

FIG. 7—ANOTHER EXAMPLE OF HONEYCOMBING
This Is a Resawed Flat-Grain Oak Board That Showed Severe Honeycombing on the Freshly Sawed Inner Surface

HOW WOOD DRIES

It is not my intention to discuss in a technical way the various phenomena of wood drying, but it is necessary to take account of the facts in general to understand the subsequent behavior of wood when it is varnished and placed in the drying oven.

As a stick of wood dries, there is necessarily set up a gradation of moisture from the center toward the surface and the outer surface therefore reaches its shrinkage point first. The tendency to shrink is resisted by the wet interior, and the outer surface is thus thrown into a state of tension while the interior is put in compression.

"SET" AND "CASEHARDENING"

Another peculiar property of wood now comes into play. When wood is dried under either tension or compression it hardens in a "set" condition, described in my article on the Phenomena of Drying Wood.[6] The final result will be either a longer or a shorter dimension, respectively, than would exist if it were to dry without stress. As the outside inevitably dries while in tension, it hardens or "sets" in an enlarged condition; then, when the interior finally dries, its shrinkage is resisted by this hardened outer shell. The initial stresses are now evidently reversed, the outside being in compression and the inside in tension.

It is the problem of the dry-kiln engineer to control the drying stresses so that the wood shall suffer no serious injury. The degree of these stresses depends upon many physical factors, among which are the original moisture-content of the wood, the rate of transfusion

of the water from the center to the surface, the consequent steepness and form of the moisture gradient, the moisture content of the outer surface, the plasticity of the wood substance, the degree of "setting," the amount of shrinkage, the tendency to collapse and the strength of the material. All these factors are influenced either directly or indirectly by the conditions maintained in the dry kiln. Under too severe conditions, both the external tension during the early stages of drying and the final internal tension may easily exceed the strength of the wood, especially while it is still somewhat moist; the result is either external surface-checking or the kind of internal checking called "honeycombing" or "hollow-horning," conditions illustrated in Figs. 6, 7 and 8. Or the second state of stress, that of tension inside and compression outside, may be over-accentuated by the kiln treatment and remain unrelieved in the wood after it is dry, to give trouble later by warping or cupping when the stick is machined or glued. These residual stresses constitute what is known as "casehardening," and can be diagnosed by cutting a cross-section and slotting it into prongs as in Fig. 9 at the left of each group.

If a casehardened board be resawed through the middle, it is sure to "cup" with the concave side inward. If stresses are present, provided they have not caused actual breakage of the fibers, it is possible to remove them in the dry kiln by a proper softening treatment at high humidity and high temperature. If such treatment is not applied properly, however, there is danger of completely reversing the stresses, as shown in the right-hand members of each group of Fig. 9.

Theoretically, it is possible to control the stresses and the setting so as to dry a stick of wood with scarcely any shrinkage and no residual stress, by an abrupt moisture-gradient based on a slow rate of transfusion. This ideal is most nearly reached in dry air at a very low temperature; but it is not approached ordinarily, as it would be a very slow process. This question is discussed in my report on A New Development in the Theory of the Drying of Lumber, With Special Reference to Shrinkage.[1]

[1] See Forest Products Laboratory files, December, 1920.

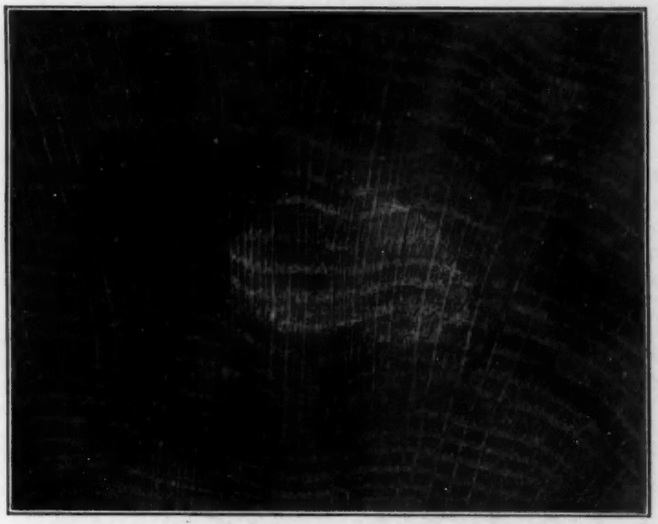

FIG. 10—"COMPRESSION CHECKS" IN A CROSS-SECTION OF OAK
These Are Due to the Increased Shrinkage Following Wetting and Redrying of a Small Portion of the Surface, within the Circle

SURFACE CHECKS IN WOOD

It will be observed that, in drying a green stick of wood in air or in the kiln, surface checks will at first tend to open up as a result of the tensile stress in the outer surface. But when the *reversal of stresses* takes place as drying proceeds, these surface checks will close up again and may even pinch tightly together by reason of the compression of the "set" surface, as illustrated in Fig. 8. The checks may indeed become invisible, even when the lumber is planed; nevertheless, they exist.

The "setting" of wood must not be thought of as in any way akin to the setting of cement, because the wood after setting is still free to shrink or swell with further changes of moisture. It appears to be more in the nature

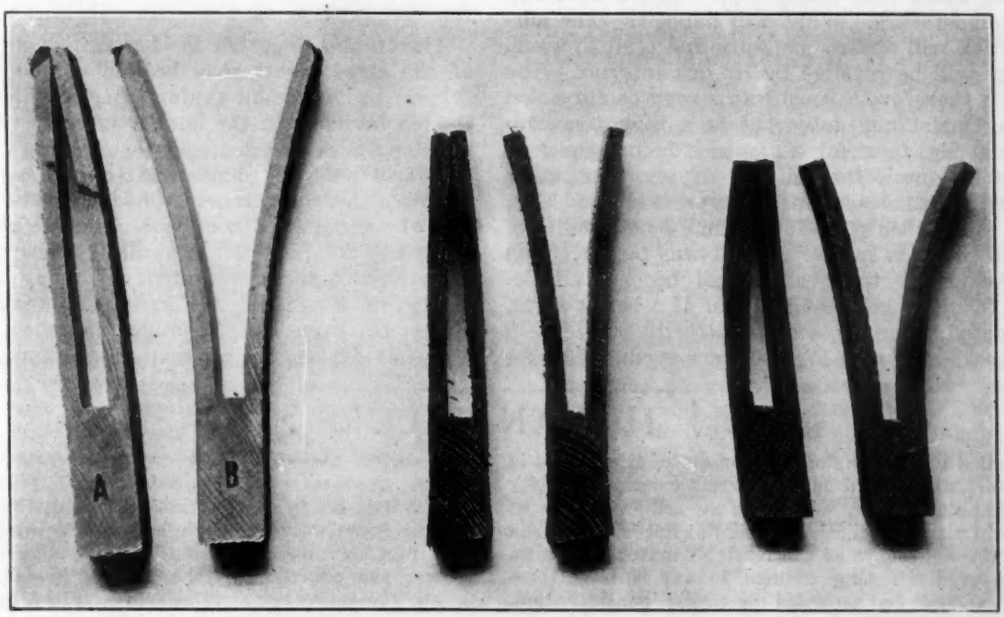

FIG. 9—TESTS FOR CASEHARDENING AND INTERNAL STRESS
The Sections at the Left in Each Group Reveal a Casehardened Condition. Sections to the Right Were Cut Adjacent to Those on the Left, from the Same Respective Boards after Steaming and Clearly Show How the Stresses Have Been Reversed. Such a Condition Is the Direct Cause of "Compression Checks." The Group at Left Is Maple; the Other Two Are Oak

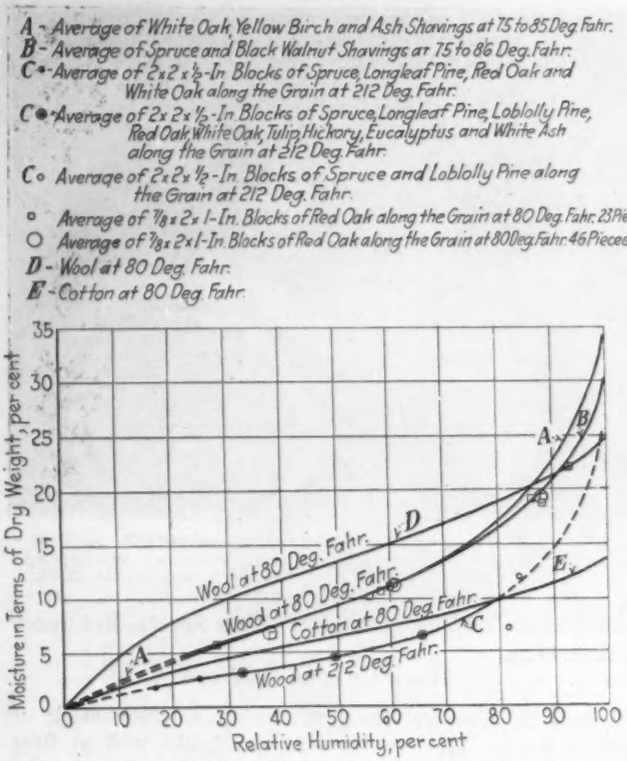
A - Average of White Oak, Yellow Birch and Ash Shavings at 75 to 85 Deg Fahr.
B - Average of Spruce and Black Walnut Shavings at 75 to 86 Deg. Fahr.
C • - Average of 2 x 2 x ½-In. Blocks of Spruce, Longleaf Pine, Red Oak and White Oak along the Grain at 212 Deg. Fahr.
C • - Average of 2 x 2 x ½-In. Blocks of Spruce, Longleaf Pine, Loblolly Pine, Red Oak, White Oak, Tulip, Hickory, Eucalyptus and White Ash along the Grain at 212 Deg. Fahr.
C ○ Average of 2 x 2 x ½-In. Blocks of Spruce and Loblolly Pine along the Grain at 212 Deg. Fahr.
○ Average of ⅞ x 2 x 1-In. Blocks of Red Oak along the Grain at 80 Deg. Fahr. 23 Pieces
○ Average of ⅞ x 2 x 1-In. Blocks of Red Oak along the Grain at 80 Deg. Fahr. 46 Pieces
D - Wool at 80 Deg. Fahr.
E - Cotton at 80 Deg. Fahr.
Moisture in Terms of Dry Weight, per cent
Relative Humidity, per cent
Wool at 80 Deg. Fahr.
Wood at 80 Deg. Fahr.
Cotton at 80 Deg. Fahr.
Wood at 212 Deg. Fahr.
0 5 10 15 20 25 30 35
0 10 20 30 40 50 60 70 80 90 100

FIG. 11—CURVES SHOWING THE RELATIONSHIP OF THE MOISTURE-CONTENT BALANCE BETWEEN WOOD AND THE VAPOR IN THE AIR AT 80 AND 212 DEG. FAHR.

The Ideal Method of Manufacturing Wooden Parts Would Be To Control the Humidity in the Shops at All Times So That This Balance Would Be Kept Constant. In That Case the Wood Would Neither Shrink Nor Swell

of a fixed deformation of the cell shapes, so that the zone in question is rendered either larger or smaller than it would be normally.

Suppose now that the stick of dry wood having these incipient but invisible surface-checks is placed in a varnish-drying room that has a high relative humidity and a high temperature. What will happen? The surface of the stick will absorb moisture and tend to swell. This tendency will be resisted by its dry interior. The surface zone is therefore thrown into strong compression stress. Being moist and subjected to a high temperature, 150 to 180 deg. fahr. for example, it becomes plastic and the cells become deformed. If drying then takes place, the surface zone sets in a compressed condition, after which, as it dries to its former moisture condition, it shrinks and becomes *smaller* than it was before. This will cause the checks to open up and become visible. Such checks, for distinction and in lieu of a better term, can be designated "*compression checks*."

The fine checks shown in Fig. 10 were produced by an action of the kind described, although in this case they were not in the wood originally. The dry section of oak was moistened in the center with hot water, and then redried; then the checks appeared. Checking of this kind is very common, although the real cause is not generally understood. It is responsible for much of the "weathering" of exposed surfaces of wood often seen in door and window sills and in exposed floors. Initial surface-checks may or may not be present; but, if present, the effect is quicker and more pronounced.

BALANCE BETWEEN MOISTURE CONTENT AND RELATIVE HUMIDITY

It is well known that, at any given temperature, the moisture content of wood comes to a definite balance with the relative humidity of the surrounding air. Curves showing this relationship at 80 and at 212 deg. fahr. are presented in Fig. 11. The ideal way to carry on the manufacture of wooden parts would be to control the humidity in the shops at all times so as to keep this balance constant; the wood in that case would neither shrink nor swell.

RELATION TO AUTOMOBILE-BODY CONSTRUCTION

To come now to the point of specific concern in automobile-body construction, when temperatures are raised considerably above working conditions, as in the varnish dryers or bake ovens, the relative humidity assumes a much greater importance and should be increased accordingly. For instance, assume the unvarnished wood to contain 7 per cent of moisture at 80 deg. fahr. This state corresponds to a relative humidity of about 37 per cent in the workshop. When the work subsequently is put into the varnish-drying room at say 150 deg. fahr., the humidity should be raised to be about 53 per cent. A lower humidity would cause some drying of the surface of the wood and the opening up of surface checks while it still was *in the drying room*. On the other hand, an excessive humidity would produce the distinctive compression-checks already explained, and these would appear *after* the sticks were removed and cooled.

CAUSES OF VARNISH-DRYING TROUBLE

The trouble reported in the varnish drying at several of the large plants may be due to one or all of three things: (*a*) incipient surface-checks which were present though invisible in the lumber prior to varnishing, combined with casehardening; (*b*) too high a humidity in the varnish-drying room; and (*c*) too low a humidity in the varnish-drying room. Checks can be produced in a similar manner by water-stain or alcohol-stain during finishing; causing surface swelling and compression with extra shrinkage on the surface during the subsequent drying, as illustrated in Fig. 10. This peculiar action is in fact the same as that producing reversed casehardening when dry lumber is steamed, as shown in Fig. 7.

HUMAN VALUES

WERE I called upon to make an estimate of life values in the United States, based on the current earning capacity of our adult population, capitalized at an ordinary rate of interest, I should place the total valuation at not less than six to eight times the aggregate of the Nation's material wealth. Surely, such a predominating element in our National economic wealth should be accorded scientific consideration, when we have seen fit to extend it for many years to the minor element. Instead, we have from an economic standpoint largely ignored the creative force that gives rise to property values. We have emphasized the effect rather than the cause, the finished service rather than the performer of the service, the temporary products rather than the permanent producer of those products.

With respect to many classes of men, the life value constitutes practically all of their business worth. The significant fact in this connection is that in many callings the greater the practitioner, the greater his skill and compensation, the more complete the loss of the business asset in the event of the passing of the life value involved. In many vocations the loss of the life value, unless hedged with insurance, almost invariably means a total loss of the capitalized business worth.—S. S. Huebner, Wharton School of Finance and Commerce.

Inspection Methods Symposium

DISCUSSION that followed the presentation of papers at the April 17 meeting of the Detroit Section is printed herewith. An abstract of each paper, as then delivered, precedes the text. The papers relate to the importance of accurate inspection and to the need for cooperation between the engineering and the production departments, and contain suggestions for improving the quality of the material produced as well as for decreasing the cost of the inspection process. Each of these papers was printed in full in the August, 1924, issue of THE JOURNAL and members who desire to read the complete text are referred to p. 437 of that issue.

INFLUENCE OF NUMEROUS HANDLINGS ON INSPECTION COST

BY A. H. FRAUENTHAL[1]

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings.]

ABSTRACT

TRANSPORTING and handling the material constitute a large part of the expense of inspection. The cost of transportation has not been considered in this paper, but only the time consumed in picking up and laying down gages and parts. A test made of the time required to scleroscope cam rollers by two different methods, in one of which the hammer was operated by a hand-bulb and in the other by a foot-pedal, showed that the former method requires 7.8 sec. per piece, the latter 6.0 sec., a saving of 30 per cent. Multiple gages that check several different parts simultaneously avoid many of the slighter movements.

But gages of this type are practicable only when they have been carefully designed and adapted to the part involved. Solid go and no-go gages are successful only when a large majority of the parts are correct. They do not indicate exact defects and should be reserved for small light parts and careful inspectors. When the tolerance is more than plus or minus 0.003 in. the flush-type indicator or "flush-button" gage is said to have proved very satisfactory. Their use in the multiple inspection and checking of water-pumps is described, as is also a fixture for checking the spiral gear on the camshaft and its mating gear on the oil-pump in ordinary camshaft inspection. Doubling up of inspection cuts down the initial gage-cost and makes unnecessary the picking up or the laying down of the camshaft or the oil-pump gear as would be the case if each part were inspected separately.

A FEW HIGH POINTS ON THE INSPECTION OF PROCESSED MATERIAL

BY C. S. STARK[2]

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

DETAILS of inspection vary in different automobile plants and can be accounted for by the fact that the larger plants have greater quantities of material in process, whereas quality-car manufacturers, having a much smaller quantity of material in process, require more machine set-ups and, consequently, are likely to produce more defective material. Paying particular attention to the inspection of threads, which previously to the design of the first Packard-Six consumed an unusual amount of time and labor because of the special standards and special taps and dies needed, and with a view to finding a more economical and at the same time more accurate method of inspecting threads, a thread-limits committee was appointed to make an investigation.

This committee recommended that the S.A.E. Standard should be adopted, and that checking should be performed by internal and external gages of the go and no-go type having only three threads in contact with the work. The advantages of this method lie in the fact that only a single movement is needed to check the accuracy of the pitch, the gage functions more easily and its use is not so tiring on the inspector, the wear is not so great and any binding that may occur indicates pitch-diameter or root-diameter trouble. The lead is checked by lead indicators. For internal threads, particularly the smaller sizes, specially-ground taps are used. The pitch-diameter of all taps is calibrated by Fortney standard measuring-wires. The lead is checked on a lead-testing machine equipped with an indicator. As a final check, the taps are placed in a screw-thread comparator, in which any irregularity is projected on a screen and magnified 200 times.

For the economical inspection of large quantities of small parts, such as machine screws, the stock to be inspected is spread out on a bench so that the general condition of the material may be visualized. By examining pieces at random, the exact percentage of defective work can be determined. This percentage varies with the part. If a percentage greater than that considered allowable is found, the lot is subjected to detail inspection. Inspectors have only one function to perform and that is to separate the work before them strictly in accordance with the gages, or to examine for defects visually in accordance with the standards supplied to them. They are not allowed to use any judgment whatever. The responsibility of disposing of dead material is vested in a committee of three men consisting of the mechanical superintendent, the general superintendent of manufacturing and the chief inspector, who visit certain departments each day according to a schedule.

[1] Chief inspector, Chandler Motor Car Co., Cleveland.
[2] Chief inspector, Packard Motor Car Co., Detroit.

MAINTAINING HIGH-QUALITY PRODUCTION

BY C. J. JONES[3]

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

INSPECTION can be maintained only through the cooperation of the engineering and the production departments and is insurance against defective material entering the product. Production alone cannot maintain the close standards of precision and accuracy that are demanded in products of the better grade. With "quality" the watchword, effort is made to have all parts correct before they are passed on to sub and major assemblies. Parts not up to standard must be rejected. Defective material is called to the attention of the head of the department and he is held responsible for seeing that the defects do not recur. By holding the head of the department, as well as the head inspector, responsible, two endless chains of inspection are provided.

To get men of the right caliber it is sometimes necessary to take them from the production departments where they have been in charge of particular lines. Instead of being a loss, scrapping the parts that are not up to standard puts those concerned on their toes, makes the workmen more efficient, and in the end results in a saving. Vendors who have been unable to work up to the required standards have been shown how to do so.

All parts received are given a 100-per cent inspection, including metallurgical, visual, heat-treating, pickling and Brinell tests. Aluminum crankcases are made with test-bars attached for testing. Every detail in the engine assembling department is watched, from the machining of the component parts to the final test, as is also every operation on the chassis, from the time the frame starts on the line until all the parts have been assembled complete. The complete chassis is then tested by men who have had considerable experience and is rechecked later to make sure that all repairs have been made. Before being loaded for shipment it receives another test and any needed additional adjustments are made or defects corrected. At the loading-dock the car is washed and receives another inspection to ascertain whether all tool-kits and parts are intact. Electrical equipment obtained from outside manufacturers is checked with precision instruments, any part rejected being returned to the vendor. All painting materials are furnished to the body builders after having received every known test in the paint test-room.

THE DISCUSSION

CHAIRMAN K. L. HERRMANN[4]:—Mr. Stark has asked regarding the experience of other plants in handling screw-threads. In our automatic-machine department we have screw-thread inspectors who visit each of the automatic machines at regular intervals to inspect the product. If, at any time, any of the machines does not produce a thread within the required specification, the inspector orders it shut-down until it has been corrected. It seems that most of the taps that are used nowadays are ground. We are having some trouble in keeping the taps to close tolerance. If any one of the inspectors asks for the 0.0005-in. tolerance, he will get it. At first we had trouble in getting the 0.0005-in. tolerance and it seems we may have to go back to larger tolerances because others do not demand similar accuracy. The ground tap, though much more expensive in first cost, is much the cheaper tap to use. Accuracy, as Mr. Stark has pointed out, does not cost enough more to offset the longer life of the ground tap. A ground tap at three times the cost of a standard commercial tap will cost about one-half as much in holes tapped per dollar.

D. E. ANDERSON:—What is the inspection cost per car?

C. S. STARK:—That depends entirely on the type of car produced. Between the cheaper and the higher-priced cars the difference in the cost of inspection is very large. You would almost have to mention definitely the type of car on which you want the cost of inspection. The cost of inspection of a high-quality car sometimes is four or five times as great as that of a cheaper car made on larger scale. Production always controls the cost.

O. D. HEAVENRICH[5]:—Mr. "Packard" says that the inspector's job is to check parts to blueprints and gages. Mr. "Lincoln" says it is often necessary to use, as inspectors, foremen or men who are familiar with the manufacture of the parts.

MR. STARK:—I have seen many high-school students who would make good inspectors.

A. H. FRAUENTHAL:—As an inspector, the production man very often has too much sympathy for the foreman's problems. The result is that the highest quality is not attained. An inspector who does not possess a great amount of production knowledge will ask offhand for something impossible and work down to something that is just about possible. The sympathetic ex-production man will not do this.

MR. STARK:—The Packard Motor Car Co. does just the opposite; it attempts so far as possible to select its foremen from the inspection force.

C. J. JONES:—I might remind you that my remark was that we canvassed the whole organization and in some cases selected a likely sort of fellow from the production organization who was thoroughly familiar with the little tricks of "getting things by" that the average student from a high-school or college would not be familiar with.

P. W. RHAME:—Do you judge a flush-pin entirely by feel?

MR. FRAUENTHAL:—Yes, because we do not use a flush-pin on work of such accuracy that it requires anything better than feel.

MR. RHAME:—What is the ratio of inspectors to productive operators?

MR. STARK:—I made a canvass some time ago of all the automobile plants in Detroit and found that the ratio varied from 1 to 9 to 1 to 24.

MR. RHAME:—What about the policy of supplying small vendors with gages? Should that be done?

MR. FRAUENTHAL:—We have tried both policies. Although, originally, we thought it safer to give them gages, we could not control the maintenance and the use of them. Gages are very easily mutilated and we were faced with the problem of disposing of material that fitted incorrect gages.

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[3] Chief inspector, Lincoln Motor Co., Detroit.

[4] M.S.A.E.—Assistant manager, Studebaker Corporation of America, Detroit.

[5] M.S.A.E.—Secretary and engineer, Guy Disc Valve Motor Corporation, Ypsilanti, Mich.

QUESTION:—Should the inspection department be under production supervision, under the engineering department or separately accountable to the management?

MR. JONES:—In my opinion, it should be entirely separate.

QUESTION:—Should the metallurgical inspection or checking of the material come under the inspection division or, as it often does, under the engineering laboratory?

MR. STARK:—I believe that it is so closely correlated to the engineering division that it should be under it.

CHAIRMAN HERRMANN:—Covering all materials, such as oils, greases, and the like?

MR. STARK:—Yes.

QUESTION:—What is the value of the scrap per car?

CHAIRMAN HERRMANN:—If we took all the parts that go into scrap, we could build 1 complete car in every 300. In our Detroit plant we build 300 cars per day and the value of the material scrapped each day amounts to the cost of the material for one complete car. There should be no salvage limits. Parts should be according to the drawings. Salvage limits foster carelessness. It is cheaper to scrap the part in the first place than to send it through in salvage lots or to take chances. It is impossible to specify all the necessary things on the drawings, but we inspect as far as the drawings specify and scrap whatever is not in accordance with the drawing. The production superintendent and the foremen are very careful, because a record is kept of each department's scrap. At the end of the month or year the amount of excess scrap may be considerably more than the amount of the salary of the foreman of a department; that alone provides food for thought.

Last week the fillets in some of our crankshafts varied more than 0.010 in. from the drawing. There were 360 crankshafts below the tolerance that went to scrap. It was a small matter and would not have hurt the shaft, but the scrap loss demanded precautions to prevent it from recurring to an extent that would be a detriment. If we should accept things that are off, it would not be long before we would be accepting sharp corners instead of curves.

H. K. GANDELOT[6]:—Mr. Jones, if you were working on an assembly line in a minor capacity, do you think you would always find sufficient incentive to put forth your best efforts at all times, especially if you were on a piece-work or gang-price basis?

MR. JONES:—I believe I shall have to refer that question to someone else because I do not believe in piecework on a high-quality car.

MR. GANDELOT:—What is the best way to keep up the morale on an assembly line?

MR. FRAUENTHAL:—In our engine assembly and in our chassis assembly, as well as in the machine department and sub-assemblies, we have a group piece-work arrangement. If the final inspector rejects a finished engine or finished chassis, because of the error of someone near the beginning of the line, the entire assembly must be torn-down and rebuilt; and the men in that group must suffer for it. This usually results in causing each man to observe carefully the work of the man just ahead of him and, if an assembly is turned-down occasionally, it acts as a wonderfully disciplinary measure.

MR. JONES:—If the man at the end of the line and the men along the line were depended upon, a number of things that would be detrimental to engines, would, after they had passed on some distance in the assembling or until they were nearly complete, be next to impossible for the inspector to detect unless the engine were entirely torn down.

MR. FRAUENTHAL:—I do not want to create the impression that the final inspector is the only one on duty.

MR. GANDELOT:—What type of indicator does the Lincoln Company use to check-up the bearing clearances as mentioned?

MR. JONES:—The ordinary dial-type indicator. It clamps on the connecting-rod and has a little extra play. It is raised up so that the point of the indicator rests on the crankshaft.

G. A. SCHREIBER:—Do some of the older S.A.E. members recall Mr. Leland's speech made during the summer of 1913, at the old Wolverine Automobile Club, when he stated that he was trying to discountinue the inspection departments at the old Cadillac plant? Mr. Leland at that time said that inspection is really a nuisance and a waste of money, and that he would take all new men from the farm and after they had been trained one way, they could not make mistakes and create scrap.

CHAIRMAN HERRMANN:—We all have great respect for Mr. Leland. I am sure that almost any farmer would make a good inspector under his direction. Of course, he could not possibly train all the inspectors nowadays. Since 1913 we have had a wonderful growth in the automobile industry, making it almost impossible to educate inspectors as formerly.

R. H. CONNER:—What is the most accurate method of checking spiral bevel-gears?

CHAIRMAN HERRMANN:—An accurate method of checking the form of spiral bevel-gears has not yet been found. In the next 4 or 5 years probably someone will appear with it. We have no equipment that will check spiral bevel-gears for the things that must be eliminated to make them quiet.

G. L. MCCAIN:—How can the engineering department render the greatest amount of help to the inspection department?

MR. FRAUENTHAL:—By getting acquainted with it.

L. GROSS:—When it is possible for the vendor to salvage rejected parts, should he consult the customer? If not, why not?

CHAIRMAN HERRMANN:—A question came up the other day relating to a foundry that was supplying us with aluminum castings and soldering up the defects. Its representatives said, why is it not all right to solder up a little defect in a crankcase or a transmission case. The answer is, How do you know what is under the soldered-up part? How deep is the hole and how will it affect the casting?

QUESTION:—What methods does Mr. Jones use in testing paint?

MR. JONES:—We depend more upon the practical tests, such as the viscosity, the bending and the weather tests. So far, we are depending more on the weather tests and the practical bending-tests, putting on various coats and subjecting them to the worst possible conditions to arrive at the life of the paint in the shortest possible time.

QUESTION:—Do you test the ingredients of the paint?

MR. JONES:—Yes.

QUESTION:—What kind of tests do you use for turpentine and for linseed oil?

(*Concluded on p.* 466)

[6] A.S.A.E.—General experimental department, Rickenbacker Motor Co., Detroit.

Organizing for Plant Maintenance Work

By L. A. BLACKBURN[1]

PRODUCTION MEETING PAPER *Illustrated with* CHARTS

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

ASSUMING that a system of inspection is more economical and effective than a system for making repairs, the author outlines a plan of organization for a large manufacturing plant. By competent supervision breakdowns and the accompanying unestimable cost of production delays are avoided. In a large plant no one man can be constantly on the lookout for trouble, but a live maintenance engineer can train his organization to watch for unusual developments, and he can hold each department head accountable for the part of the equipment that is allied with his particular trade.

The various departments of such an organization are described in turn and their functions discussed. These include the policing of the plant, protection against fire, maintaining the plant in a sanitary condition, the removal of waste material, the operation of the power-plant and its piping and wiring system, and the inspection and repairing of motors, signaling equipment and metering devices; also such other branches and subjects as the carpenters, the millwrights, the tinsmiths, the machine-repair department, designing and planning, construction work in connection with the repairing and rearrangement of buildings, the storeroom, safety education, first aid, and record-keeping for determining the cost of manufacturing and for the purchasing of supplies.

The organization chart appended is said to have been developed, not with any particular plant in mind, but with the idea that it could be added to or cut down according to the size of the plant or the need of the operation, and that each industrial engineer will work out the details necessary to meet the conditions peculiar to his own company.

THE scope and success of a maintenance organization depend upon the initiative and ambition of the maintenance engineer. The scope of his work covers the principal fields of applied engineering: mechanical, electrical, civil, power and structural; sanitation, ventilation, fire-protection, plant-policing, plant-layout; production, production-machinery and plant-transportation.

The duties of a maintenance engineer are so varied and cover so broad a field that it is difficult to enumerate them. I will, however, attempt to outline an organization that will take care of every detail that might arise, and will dispose of it with the least possible delay to production.

In the automobile-manufacturing field the immediate superior of the maintenance engineer, sometimes termed the plant engineer or the works engineer, is usually the manufacturing manager. To him the maintenance engineer is responsible for keeping the grounds, buildings and equipment of the plant in a satisfactory operating condition, guaranteeing, so far as he can by vigilance, foresight and intelligent study of the equipment under his supervision, the maximum production at all times.

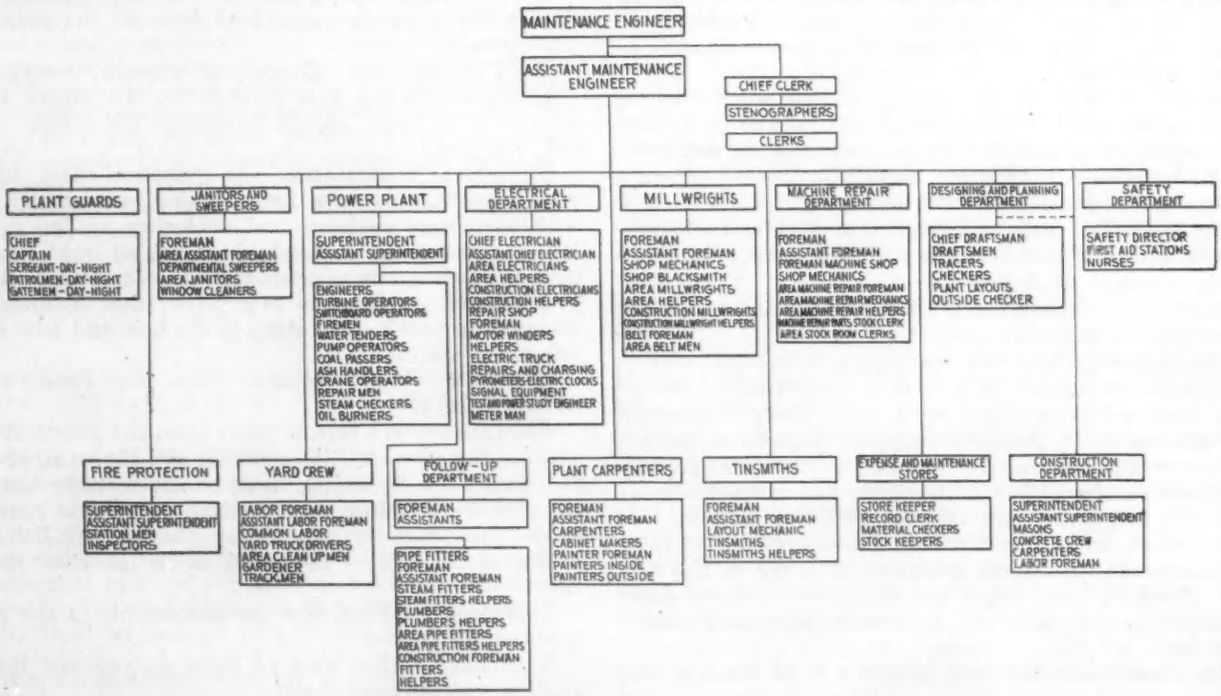


FIG. 1—MAINTENANCE ORGANIZATION CHART

This Chart Is Based on the Assumption That Each Department Will Take Care of Its Own Construction Work. It is Not Intended to Apply to Any Particular Plant But Should Be Enlarged or Curtailed to Meet the Peculiar Needs of Each Company

[1] Plant engineer, Olds Motor Works, Lansing, Mich.

Fig. 1 outlines graphically a maintenance organization. Each group consists of a particular trade that has more or less well-defined duties and obligations to fulfil. To select a leader for each of these groups, who will be alert, ambitious, and interested in the welfare of both the employes and the employer, is no easy task. To obtain the best results from the department heads, there must be, first, some definite method of procedure for the execution of work orders, and, secondly, a spirit of co-operation, or willingness to help the other fellow, so that they will work as a unit. Responsibility develops the individual; and the greater the responsibility the more pride will he take in making the best showing. This is particularly true of an average mechanic who is more or less zealous of his trade. Therefore, in a growing plant

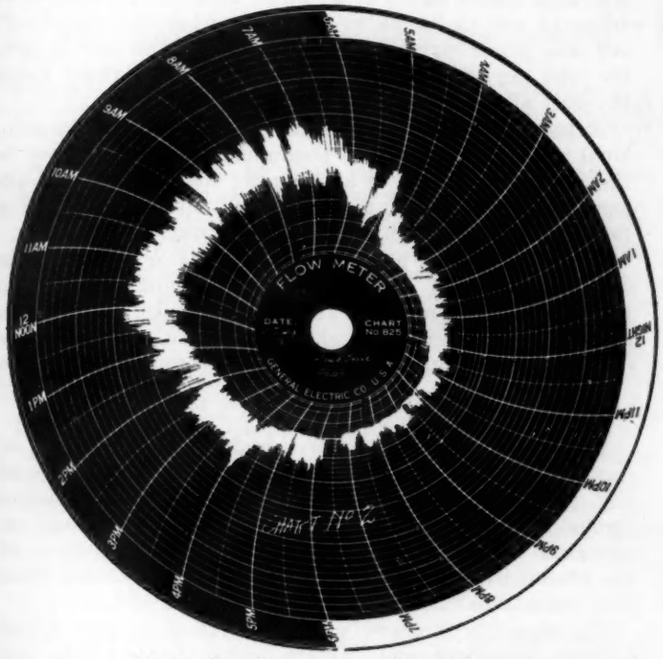


FIG. 2—THE WORK OF THE STEAM-CHECKER
This Chart from a Steam-Flow Meter Shows the Record for Each Hour of the Twenty-Four, and Indicates the Savings That Are Possible by Supervising the Use of Steam for Heating Factory Buildings

he looks forward to taking his part in the development, and to mingling with the ordinary monotony of upkeep and repair work a demonstration of his ability along his line. If he feels that the big jobs will be contracted for that he could handle just as well as, if not better than, a great many contractors that are brought to the plant to do the work, he becomes discouraged and loses interest. This is also true of the mechanics that work under him.

The organization chart has been developed, therefore, on the assumption that the department will take care of such construction work and plant rearrangement as will give steady work to a limited number of men and at the same time justify the employment of higher-calibered men, as heads of departments, than could be interested in purely maintenance work.

PLANT POLICING

The most desirable type of plant guard that we have found is an ex-service man between the ages of 45 and 55. If he is a retired officer, he has handled men as men and not as criminals, he appreciates the value and meaning of orders, and he executes them. Quite often a visitor's impression of a plant is formed by the reception accorded him by the officer at the gate. Courtesy, therefore, is essential. The day duties of this department consist of patrolling the plant; enforcing the rules of the plant regarding smoking, gambling and "horse-play," and regarding the employes of one department roaming about departments other than their own; questioning strangers that are without passes; giving general information to employes regarding the rules and regulations; reporting unsafe practices of employes, and the condition of the buildings and the grounds, including

19 ___ ELECTRICAL POWER DATA

MONTH	KW. DEMAND	TOTAL KWH.	POWER FACTOR	PENALTY	BONUS	TOTAL KWH. TO DATE	TOTAL BILL TO DATE	TOTAL MONTHLY NET BILL	RATE PER KWH.
JANUARY									

19 ___ ELECTRICAL POWER DISTRIBUTION

MONTH	TOTAL KWH.	MOTOR PLANT	PER CENT	AXLE PLANT	PER CENT	SHEET METAL	PER CENT	AIR COMPRESSORS	PER CENT	PLANT LIGHTING	PER CENT	PAINT DEPT.	PER CENT	BODY DEPT.	PER CENT
JANUARY															

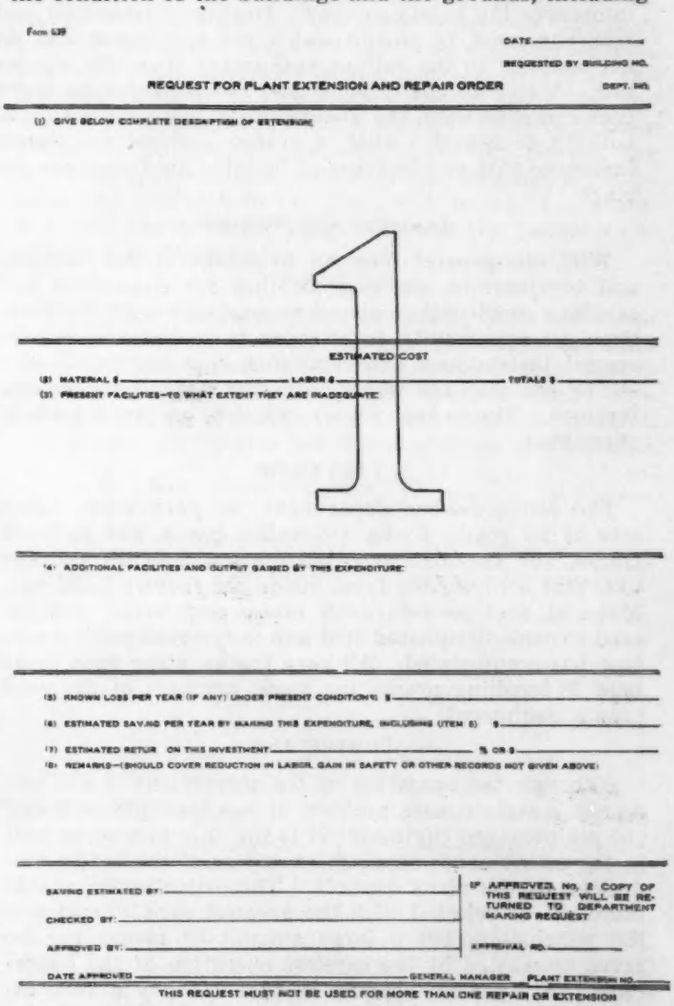
STEAM POWER ANALYSIS

19___ MONTH	POUNDS COAL CONSUMED	COST OF COAL	POUNDS OF WATER EVAPORATED	EVAP. F. & A. 212	COST OF STEAM PER 1000 LB.					CARS PRODUCED	REMARKS
					FUEL	LABOR & SUPT.	L. & M. REPAIRS	FIXED CHARGES	TOTAL COST		
JANUARY											

AIR ANALYSIS

19___ MONTH	CU. FT. AIR ELECTRIC COMPRESSORS	CU. FT. AIR STEAM COMPRESSORS	CURRENT FOR AIR KWH.	STEAM FOR AIR POUNDS	COST OF AIR PER 1000 CU. FT.				
					STEAM	CURRENT	L. & M. REPAIRS & OPER.	FIXED CHARGES	TOTAL
JANUARY									

FIG. 3—THE MAINTENANCE ENGINEER'S READY REFERENCE RECORDS
These Are Digests of More Complete Data Compiled by the Different Departments


Form 539

DATE

REQUESTED BY BUILDING NO.

REQUEST FOR PLANT EXTENSION AND REPAIR ORDER DEPT. NO.

(1) GIVE BELOW COMPLETE DESCRIPTION OF EXTENSION:

ESTIMATED COST

(2) MATERIAL $ LABOR $ TOTALS $

(3) PRESENT FACILITIES—TO WHAT EXTENT THEY ARE INADEQUATE:

(4) ADDITIONAL FACILITIES AND OUTPUT GAINED BY THIS EXPENDITURE:

(5) KNOWN LOSS PER YEAR (IF ANY) UNDER PRESENT CONDITIONS $

(6) ESTIMATED SAVING PER YEAR BY MAKING THIS EXPENDITURE, INCLUDING ITEM 5) $

(7) ESTIMATED RETURN ON THIS INVESTMENT % OR $

(8) REMARKS—(SHOULD COVER REDUCTION IN LABOR, GAIN IN SAFETY OR OTHER RECORDS NOT GIVEN ABOVE):

SAVING ESTIMATED BY:

CHECKED BY:

APPROVED BY:

IF APPROVED, NO. 2 COPY OF THIS REQUEST WILL BE RETURNED TO DEPARTMENT MAKING REQUEST

APPROVAL NO.

DATE APPROVED GENERAL MANAGER PLANT EXTENSION NO.

THIS REQUEST MUST NOT BE USED FOR MORE THAN ONE REPAIR OR EXTENSION

FIG. 4—REQUEST FOR PLANT EXTENSIONS AND REPAIRS
This Form is Used by Foremen in Applying for Authority to Make Necessary Improvements and Gives the Reasons for Making the Request

water, steam, gas or air leaks; enforcing traffic rules, and preventing the damaging or removing of company property from the plant. The night force is required to make regular rounds hourly, to send in signals from every station and to watch closely for unauthorized persons roaming through the plant and for anything that might cause a fire or resemble a fire hazard.

Fire Protection

In a plant in which paints, varnishes, oils and combustibles are handled the fire risks are reduced by rigid inspection. The inspectors must be familiar with the processes, must provide ways and means for reducing the risk to the minimum, and follow them up every day. Spray booths, unless properly cleaned, are very dangerous and should have careful attention, especially where duco has been used. Oily rags when allowed to accumulate constitute the most common hazard.

The inspectors should be thoroughly conversant with all the regulations of the National Board of Fire Underwriters as recommended by the National Fire Protection Association, be required to study the pamphlets one at a time and be questioned by the superintendent of the department. When the study and the examination have been completed the inspector should apply his knowledge by a rigid inspection of his particular area for failure to observe the points covered. During construction and rearrangement he should watch for any items that do not conform to the rulings and report them for correction. When all the changes and recommendations have been complied with, the underwriters' inspector will have nothing to report. Such a system assures the lowest insurance rate on the types of building that compose the plant.

Janitors and Sweepers

With one general foreman in charge of the sweepers and the janitors, the responsibility for cleanliness and sanitary conditions is placed on one man. At the same time, an opportunity is afforded to make a saving by special instructions and teamwork that can be worked out by one man but would be rather difficult for several foremen. The unkept corner, which is no man's land, is eliminated.

Yard Crew

The common-labor department, or yard crew, takes care of all roads, docks, sidewalks, lawns, and railroad tracks, and the moving of all crating, rubbish and the like, that accumulates from inside the factory buildings. Material, such as returnable crates and boxes, is delivered to some designated spot and is removed when a carload has accumulated. All yard trucks, other than those used in handling production stock, are part of the yard crew's equipment.

Powerplant

Although the operation of the powerplant is not primarily a maintenance problem, it has been placed under the maintenance engineer. It is the only producing unit in the maintenance department and on it the entire production of the plant depends. The organization should therefore be selected with the greatest care. Service is the watchword, but a large amount of money can be saved or wasted by the careless operation of the boiler-room. A 1-per cent saving in fuel will pay a very attractive salary to a good combustion engineer in a boiler plant of 2000 hp.

Boiler-room records constitute one of the most important items of the operating engineer. Making steam is more than simply burning coal and boiling water. Steam-flow meters, boiler feed-water meters, CO_2 recorders, gages and temperature recorders supply the necessary data with which the engineer may check the leaks. Without this equipment, thousands of dollars may be expended because of the guesswork of either experienced or inexperienced men.

Boiler-Room Equipment

Several years ago power engineers went into a boiler-room of 2000-hp. capacity that did not have a meter for measuring a single item of water, steam or air; but the coal was weighed. They did not have the slightest idea at what efficiency the plant was operating and they had less idea where and why so much coal was consumed, or when to put on an extra boiler or when to take it off. All was guesswork. I believe I am safe in saying that the cost per year of guessing is more than three times the cost of the entire meter installation.

After the installation of steam-flow meters on the principal steam-supply mains, steam-checkers were added to the powerplant staff. Fig. 2 shows the savings that are possible by supervising the use of steam for heating factory buildings. The chart tells its own story.

The powerplant generally maintains a repair crew that takes care of ordinary repairwork and upkeep. In general, it is composed of all-round mechanics, from masons to blacksmiths, and, except in cases of a major breakdown, does all the repairwork of whatsoever nature.

Pipe-Fitters

I have placed the pipe-fitters under the supervision of the power superintendent because a large percentage of the piping throughout the plant carries powerhouse commodities. As the power superintendent is held responsible for the efficient operation and distribution of the commodities, he should have supervision of the force that maintains them in first-class condition.

The pipe-fitters' crew is composed of steam-fitters and helpers, plumbers and helpers, construction-crews and area-men, who check leaks, waste and abuse of equipment, and do the work of installing new air-drops and steam or water connections, renew leaky air-hose, turn in leaky air-drills or wrenches to the repair department, maintain generally the equipment in first-class condition and relieve the telephone to the maintenance engineer's office of the duty of reporting minor defects.

Electrical Department

With the increasing popularity of the individual-motor drive the electrical department grows in importance. When a motor burns out the machine is shut-down until the motor can be changed. It may be true that several machines of the same type are engaged in the same operation but there may still be a delay in production. Burn-outs and other motor troubles can be avoided by the right kind of inspection and a proper system of cleaning. Under even the worst conditions this can be accomplished in some way. Since I have been connected with the automobile industry I have heard of motor troubles in the cylinder-block-machining departments. The trouble was serious, we will admit, but not so bad that it had no cure. We applied the same treatment that was used and developed by the powder industry during the war. It worked almost perfectly, but not without rigid inspection and the necessarily frequent cleaning of the motors. It works so well that a shop that formerly had four armature-winders, who could not rewind the

Form 404

FOREMAN'S ORDER

Date_____

To Department No._____

Kindly do the following work, providing cost does not exceed $15.00

Charge cost to Account No._____

Signed Foreman Department No.

Approved Factory Manager

Date Completed Foreman

THIS FORM IS NOT TO BE USED IN OBTAINING MATERIAL FROM STORES

FIG. 5—FOREMAN'S WORK-ORDER

This Form is Used When the Cost of the Work to be Performed is Less Than $15 and Is Sent by the Foreman of the Department Requesting the Work Direct to the Department That Does the Work

armatures as fast as they burned out, now has one winder who takes care of all the work.

An electric motor will not run indefinitely without care. Its life is proportional to the character of the machine that it is driving. To insure the best service, electricians and helpers of the proper number to care for the motors are located in the areas from which they can operate best. In a motor plant, for instance, one electrician and a helper can take care of about 300 motors and in a plant of 800 machines can keep the number of burned-out motors down to an average of about 3 per month. The area men have a small crib for making repairs and for miscellaneous supplies, such as fuses, lamps, cleaning materials, bolts, nuts, washers, and the like. At each crib is a whistle with which the area man can be called in case of emergency.

SIGNALING EQUIPMENT

All signaling equipment, such as the auto-call system, the fire-alarm or night watchman's system, the electrical time-clock system, and all heat-control instruments and potentiometers, is placed in the electrical department under one man, with whatever help maybe necessary to check the equipment and assure perfect operation at all times. All the work is so similar in construction and in operation that one man can handle the combination very efficiently.

In the testing and meter departments we try to accumulate data that will be of value to the machine designers and the cost department and for our own protection. A recent survey of motor sizes showed that a large percentage of motors were considerably oversize, a few just right, and a very small number overloaded. This condition causes low operating-efficiency, low power-factor and unnecessary investment in oversize motors.

The question of accurate departmental cost is becoming more necessary as the knife of competition continues to cut in. To meter accurately the consumption of gas, water, oil, steam, electricity and air in every department, would be ideal, but would be rather expensive. Some of the utilities are more easily estimated than are others. Steam for heating can be distributed very accurately on a basis of the cubical content of the building, its exposure type, and the like; lighting can be estimated on a basis of the wattage installed and the nature of the operation. To estimate electricity for power is more or less a hopeless job; but, on the other hand, the power can be easily metered. The meter department should therefore measure all utilities, so far as is practicable, and apply the cost to departmental expense rather than to a general burden or overhead expense.

CARPENTERS

The work of the carpenter crew is varied and covers a broad field of wood-working. It may be called on to do "rough" work one minute and in the next be called to the general manager's office to repair a chair or a desk drawer.

This force is composed of all classes of carpenters from the "wood butcher" to the cabinet-maker; the shop should be well equipped with modern wood-working machinery that will enable it to turn out, as it is often required to do, equipment in quantity for the operating department.

MILLWRIGHTS

As the electrical department increases in size with the use of the individual-motor drive, the millwright crew decreases, owing to the absence of overhead line-shafting and belting. They still maintain, however, a very strong position in the organization. Millwrights receive all the machinery at the plant, unload it and place it ready for setting-up by the tool men and for wiring by the electricians. Conveyors, both power and gravity, are maintained by area men, who must be "on the job" every minute to make sure that the power conveyors have been properly oiled and inspected and that every precaution has been taken against a breakdown. A minute of the lost production of a long conveyor is multiplied by the number of men waiting for the conveyor to move to their stations. Outside the machine-repair department, the millwrights should take care of all the mechanical equipment and ironwork in the plant, and have a shop equipped with the necessary machinery and the mechanics to handle such repairs.

TINSMITHS

The tinsmith department probably does more new work than any other maintenance department. Its work consists of designing and building safety-guards, splash-guards for production machines, spray booths, ventilating systems, blow-pipe work, and all sorts of metal containers and baskets for the production departments.

MAINTENANCE ORDER No. M_____

DATE_____

TO DEPARTMENT NO _____ KINDLY DO THE FOLLOWING WORK, AND CHARGE THE ABOVE ORDER NUMBER

THIS WORK TO APPLY TO C. M. W. MACHINE NO._____ ONLY

COPIES OF THIS ORDER TO

DATE FINISHED FOREMAN

MATERIAL			LABOR			LABOR			SUMMARY	
DATE	REFERENCE	AMOUNT	DATE	REFERENCE	AMOUNT	DATE	REFERENCE	AMOUNT	DATE	
									MATERIAL	
									LABOR	
									TOTAL	
									ACCOUNT	
									DEPARTMENT	

FIG. 6—WORK-ORDER USED BY MAINTENANCE ENGINEER

When the Cost of the Work to be Done Amounts to More Than $15, the Approval of the Maintenance Engineer Must Be Obtained

Building high-temperature baking-ovens of the sheet-metal type has also been found quite profitable. The shop equipment is not expensive, but essential to economical work in sheet metal.

Machine-Repair Department

The work of the machine-repair department begins with the arrival of the machines in the plant. Every machine is numbered and a card record is made for it. This record should contain all the data necessary for complete identification by the manufacturer. On the back of the card should appear the names and the numbers of parts that are subject to breakage or wear. This list is checked by the machine-repair foreman and passed on to the office of the maintenance engineer to be ordered. Upon their arrival in the plant the parts are checked in, permanently marked with the machine number and the part number and are sent to the area storeroom of the machine-repair department. The possibility of waste here is dangerous unless the items are given very close supervision. It would be unreasonable to have all parts on hand that might break, but quite good business, on the other hand, to have a few parts left over when the work is finished, rather than have a poor record of interrupted service and lost production because no special parts were on hand to meet emergencies.

The personnel of the department should consist of the highest-grade mechanics, next to tool-makers, that can be secured. The shop should be complete in every detail for building all kinds of parts for machines and to it all major repairs will be sent. In each large machine-area will be located a stockroom, for repair parts peculiar to the special types of machine in that area, and tools and machines for making minor repairs on machines that can be repaired without moving them out of the department. In each area will be a foreman with the necessary number of mechanics trained in preventing breakdowns by proper care, oiling, and instructing operators on the weak points of the machines. Breakdowns on productive machinery are costly; the most rigid inspection should be made regularly and the condition of machines noted and reported to both the operating and the maintenance departments. If a machine is found to be in poor condition, arrangements should be made for overhauling it.

Designing and Planning

The development of major and of most minor projects is in the designing and planning department. Its part of the program is to prepare plans and specifications with which the construction department can work, to supervise the construction, interpret the plans and the specifications, and see to it that they are followed. It should also keep cost records in such shape that they will be of value in future estimating as well as in distributing the cost in determining the depreciation of buildings.

The planning department should always anticipate production, that is, have the plans worked out for future expansion, in the way of the additional floor-space required for increased production. This will include a detail layout of every department with all the special mechanical-handling devices that will tend to cut the cost of manufacturing.

Construction

With a building program that can be stretched over several years, there is no question as to the saving that can be shown by doing the work with a plant crew. One large project, however, does not justify organizing and equipping a construction department. It is better to contract for the general building, at least, and to take care of the mechanical features with the plant departments. This arrangement obviates the differential in the rates of common labor, carpenters, and the like, for construction labor is nearly always a little higher-priced than plant-maintenance labor.

All major repairs and the rearrangement of buildings can and should be taken care of by this department. It is work that must be carefully planned by the production department in order that production shall not be interfered with and assurance must be given that the order will be executed within a given time.

Expense and Maintenance Stores

The stockroom for the department resembles a country cross-roads store in the variety of the articles carried. It would be very easy to stock this storeroom provided no limit were placed on the investment. By referring to a mill-supply catalog and ordering by page practically all the items shown for millwrights, carpenters, plumbers, steamfitters and electricians, the demands could be met. But these are not the conditions under which the average stockroom is run. Keep the inventory down to the minimum and let the jobber carry as much of the stock as you can; buy economically, in small quantities. Have bins tagged with the minimum and the maximum stock and also have these stocks noted on inventory cards that are kept up to the minute. When the stock drops below the minimum the record clerk should make a requisition that will bring it to the maximum unless the item has been changed to some other make or specification, in which case a new card is made out and the old one marked obsolete. For convenience to all departments the main tool-crib is located nearby and is under the supervision of the storekeeper.

Safety

The safety department consists of a director and area assistants, whose work is mostly educational after all the machines have been properly guarded. A recent anlysis of accidents in our plant for a period of one year does not show that accidents are more numerous at any particular hour of the day, nor on any particular day of the week, than on any other. A further analysis shows that 64 per cent of the total number of accidents are to the hands and that 35 per cent of this number are caused by handling stock. These facts show that the work of the safety directors consists principally of personal instructions to the new men, to teach them how to use their hands and their heads.

The first-aid section of the safety department comprises a head nurse, in charge of all the supplies, and the area nurses. In each of the large machine-departments there should be a nurse to administer first aid and to send the more serious cases to the company doctor.

Records

All records pertaining to the maintenance department are handled by the chief clerk. These records cover the requisitions and specifications for coal, gasoline, fuel oil and lubricating oil, with the monthly distribution according to the meter-readings. A complete record of all machinery, motors and equipment, with their location, is kept uptodate by requiring that all orders for moving

(*Concluded on* p. 448)

Tool Designing for Production Manufacturing

By P. V. MILLER[1]

PRODUCTION MEETING PAPER *Illustrated with* DRAWINGS

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

TO meet the increased demand for machined metal products, manufacturers of Machine-tools and cutting-tools have devised methods for greatly increasing the production of parts per man and per hour. Improvements in the tools and the materials have aided, but the greatest saving of time has been accomplished by improving the methods of holding the work during the machining operations. The most important points to be considered in the designing and the building of tools are discussed by the author, with special reference to the more common types of drill jigs and milling fixtures.

With the drill press, proper planning of the jigs and tools is essential and quick and easy handling of the work must be assured. The first thing to be considered in preparing a tool line-up is the locating of the work; but of equal importance with it is the system of holding or clamping the work in the jig. Here a study must be made to determine carefully the directions of the thrusts. The common method of securing or clamping is by means of a screw, with a nut and a hand-knob or a hand-wheel for putting pressure on the clamp. The cam type of clamp can be operated more rapidly than can the screw and nut, but it may be loosened by vibration. When the maximum pressure is desired to hold the work firmly in place the best style of clamp is one having a firm rest at the back and a suitable stud and nut between the work and the clamp-seat. When the space is limited, a direct-clamping screw, with the end resting on the work, may be satisfactory. If the pressure on the work is to be distributed among several points, rockers or equalizers may be provided. A clamp bearing on a flat surface of the work should have a suitable radius at the rear clamp-seat with a spherical seat under the nut or the washer to allow the clamp to float freely over the work. When the weight of the jigs is so great that they cannot be moved readily by hand, a suitable cradle should be provided to allow the jig to be turned to the different positions. Jigs and fixtures are differentiated by the author but the same general principles are said to apply to both.

When designing a fixture it is necessary to provide suitable keys or dowels for locating it accurately on the machine table. The cost of tools should be given careful consideration when planning operations and care should be taken that the design and the workmanship shall be of the best. If the final cost of production is dependent on the accuracy and efficiency of the tool, it is important that all unnecessary movements of the operator should be avoided.

Tolerance should have careful attention, for the effort of a toolmaker to work to unnecessarily close dimensions will mean needless expense. In plain-ground cylindrical or flat work, the minimum tolerance that should be allowed the toolmaker is 10 per cent of the working limits and twice this amount in the center distance between the drill-bushings. When production is not heavy and operation is intermittent, it is not economical to spend much money on tools, but whatever is built should be accurate and practical to operate.

DURING the last decade the greatly increased demand for machined metal products, coupled with the shortage of skilled labor and the increased wage-cost, has forced manufacturers to devise methods for greatly increasing the production of parts per man per hour. The manufacturers of machine-tools and cutting-tools, and of tool-steels and alloys, have helped very materially by making improvements in their products that greatly reduce the actual cutting-time necessary. It is generally agreed, however, that the greatest saving of time and labor has been accomplished by the improved methods of holding the work during the machining operations. It will be our object in this brief article to bring before the reader the most important points to be considered in the designing and building of these tools. Under the subject of tool design, we must, of course, include the design of all devices used in connection with machine-tools for the machining of the work, but in this article we will cover only the more common types of drill-jigs and milling fixtures.

The drill-press is perhaps the most simple as well as the most widely used machine-tool. Too often the jigs and tools to be used with it are not properly planned. If the maximum production is to be obtained. Every precaution must be taken to assure quick and easy handling of the work and of the tools. Very often the actual cutting-time required for drilling a hole is short, perhaps only a few seconds; although there may be several holes to drill and ream in the one operation, it can readily be seen that, if the maximum production is to be secured from the machine, the jig must be so designed that no time will be lost in loading or unloading the work.

LOCATING THE WORK

In preparing a tool line-up for operations to be performed on a certain piece, the first thing to consider is the location of the work in the various jigs and fixtures. There are times when it will be necessary to vary the points of location in certain operations, but this should only be done after a very careful analysis of the machining operations and the relation that each finished surface bears to the others. In the majority of cases it will be found advisable in the early operations to machine certain surfaces that can be used as locating points for the work in subsequent operations.

In the first operation, drilling, it will, of course, be necessary to locate from certain rough cast surfaces. The designer should be careful to choose points that are sure to be fairly uniform in the castings, and to avoid such surfaces as the parting-line of the fiask, as is shown

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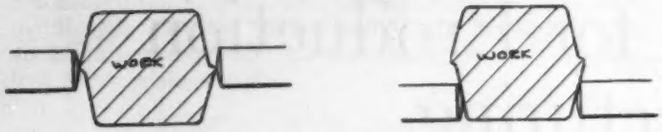

FIG. 1—METHOD OF LOCATING WORK FOR DRILLING
Locating Points Should Be Chosen That Are Fairly Uniform in the Castings. Such Surfaces as the Parting-Line of the Flask, Finish Pads, or Bosses Should Be Avoided

in Fig. 1, and also finish pads or bosses, or cored surfaces. These are liable to vary, as several patterns may be used in the foundry to give the quantity required for the production rate. The locating buttons used for this purpose should be adjustable, to allow the operator or set-up man to keep the work properly located in the jig. Slight changes produced by warpage in the pattern or by wear in the die are sure to affect the material; and it will be necessary from time to time to make slight adjustments in order to keep the machining uniform.

Having drilled and reamed one or more holes that are closely dimensioned to other finished surfaces of the work, it will be possible to locate the part accurately for other machining operations with pins or plugs; and

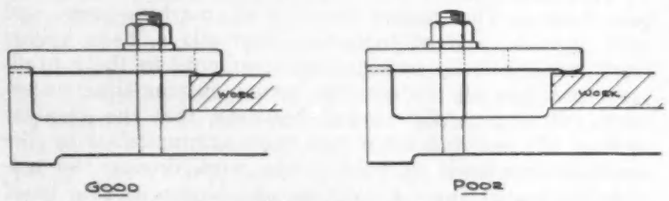

FIG. 2—METHOD OF APPLYING A CLAMP
When a Clamp Is Secured by Means of a Screw with Either a Nut, a Hand-Knob or a Hand-Wheel, the Stud Should Be Located So That a Firm Pressure Is Exerted by the Clamp on the Work

these same points should be used in all subsequent stages of the machine work. Any deviation from this rule will allow an accumulation of errors owing to variations in the machining that may cause serious errors, and result in the rejection of the work.

METHOD OF HOLDING OR CLAMPING

Of equal importance with the method of locating the work is the system of holding or clamping it in the jig. Several types of jig are in common use, such as the template, the open style, and the box jig, each of which has its field. The method of clamping may vary, but it is always well to analyze an operation carefully to determine the directions of thrust and, whenever possible, to allow the thrust of the cutting-tool to be carried through the work to a rigid pad or to a button. Often the pressure of the cut is light and because of the form of the work, it may seem desirable to locate the piece so that the thrust of the tool can be carried directly by the clamp itself. Whenever this is necessary, care should be taken to provide clamps of ample strength and rigidity, to prevent any movement of the work while machining. Further care should be taken when designing the jig to eliminate any chance of bending or distorting the piece when the clamp-screw is tightened. A clamping-point should always be directly above a suitable pad or a button that will take the pressure of the clamp without distorting the work itself.

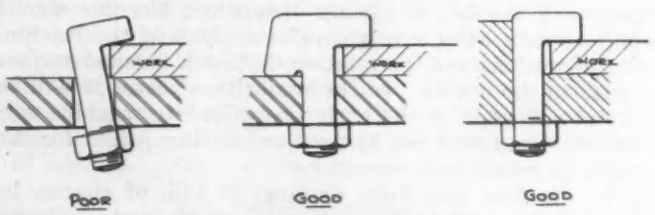

FIG. 3—HOOK BOLT CLAMPS
When the Space Is Limited, a Direct-Clamping Screw, with the End Resting on the Work, May Be Satisfactory, but Care Should Be Taken to Support the Stud So That No Section of the Jig Itself Will Be Unduly Strained

A common method of securing a clamp is by means of a screw with a nut, a hand-knob or a hand-wheel for bringing the pressure down on the clamp, a good and a poor way of applying the clamp being shown in Fig. 2. In fixtures of comparatively light construction and for work that is not too heavy, a cam type of clamp may be used. The cam, of course, can be operated more rapidly than can the screw and nut, for one movement of the lever will bring the clamp firmly into place. Often it will not be practicable to use a cam, however, as vibration or a heavy thrust may loosen it and this naturally, may result in spoiled work or a broken tool. When the maximum pressure is desired, to hold the work firmly in place, the best style of clamp is one having a firm rest at the back and a suitable stud and nut midway between the work and the clamp-seat. If several clamps of this type are to be used on the same jig, it is advisable to use studs and nuts of the same size so that they all may be tightened by the same wrench, thus avoiding the waste of time occasioned by changing wrenches. If a comparatively light pressure will hold the work securely for machining, or if a heavy or variable pressure is likely to distort the work when clamping, a hand-knob or small hand-wheel may be used, instead of a nut, for securing the clamp.

USE OF DIRECT CLAMPING SCREW

At times, when the space is limited, a direct-clamping screw, with the end resting on the work, as is shown in Fig. 3, may be satisfactory, but care should be used to make sure that no section of the jig itself will be unduly strained when this is done. In box jigs it is best to avoid this method of clamping if it is likely to strain or distort the jig-leaf, an illustration of the correct and incorrect methods being shown in Fig. 4. Also, with the variations common in rough material, the danger is always present that the screw will not be returned far enough to allow the work to be properly located.

Sometimes the contour of the work will be such that the pressure of the clamp should be distributed equally among several different points and, as it is impossible to tighten two or more clamps to give the same pressure, it will probably be best to provide one clamp with rockers or equalizers to distribute the pressure suitably at various points. This clamp, of course, will be operated more rapidly than will several separate clamps and very often may be used simply as a time-saver.

If the clamp is to bear on a flat surface of the work, a suitable radius should be provided at the rear clamp-seat with a spherical seat under the nut or the washer to allow the clamp to float freely over the work. If this design is followed, the clamp will always give a direct pressure on the work and will hold it securely while machining.

An important point to be considered, in the case of jigs that are moved around on the table to allow several holes to be drilled during one operation, is the weight. In the case of the larger jigs, cast iron is commonly used for the body; and it is always desirable to rib the casting at points where the clamping strain or the thrust of the tools is liable to stress the metal to a degree. To maintain the proper rigidity, it will frequently be neces-

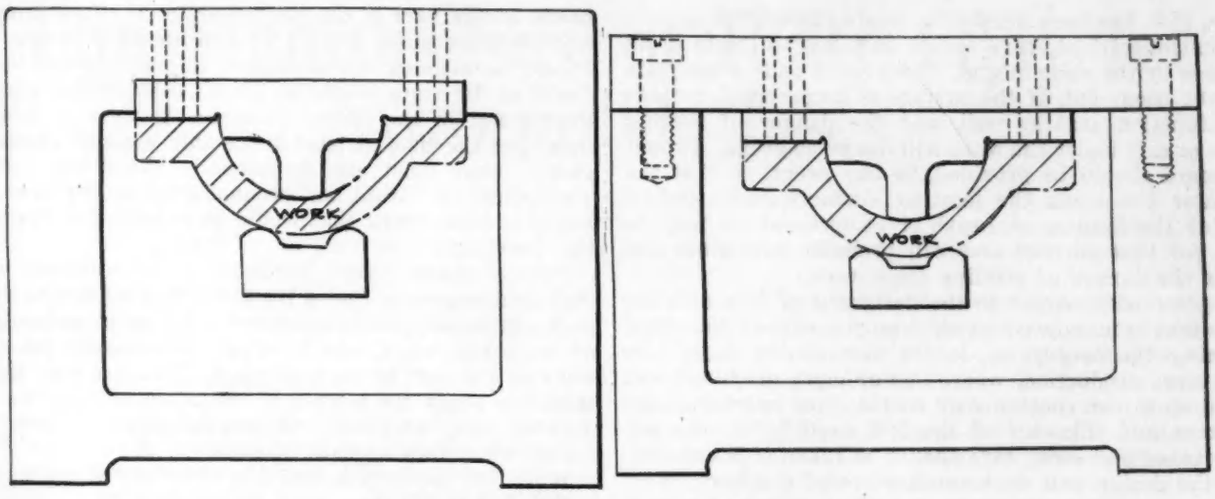

FIG. 5—SIMPLE CONSTRUCTION SAVES EXPENSE
The Built-Up Construction Shown at the Right Is Usually Cheaper than That at the Left, the Cost of the Extra Parts Being More than Compensated For by the Time Saved in Machining

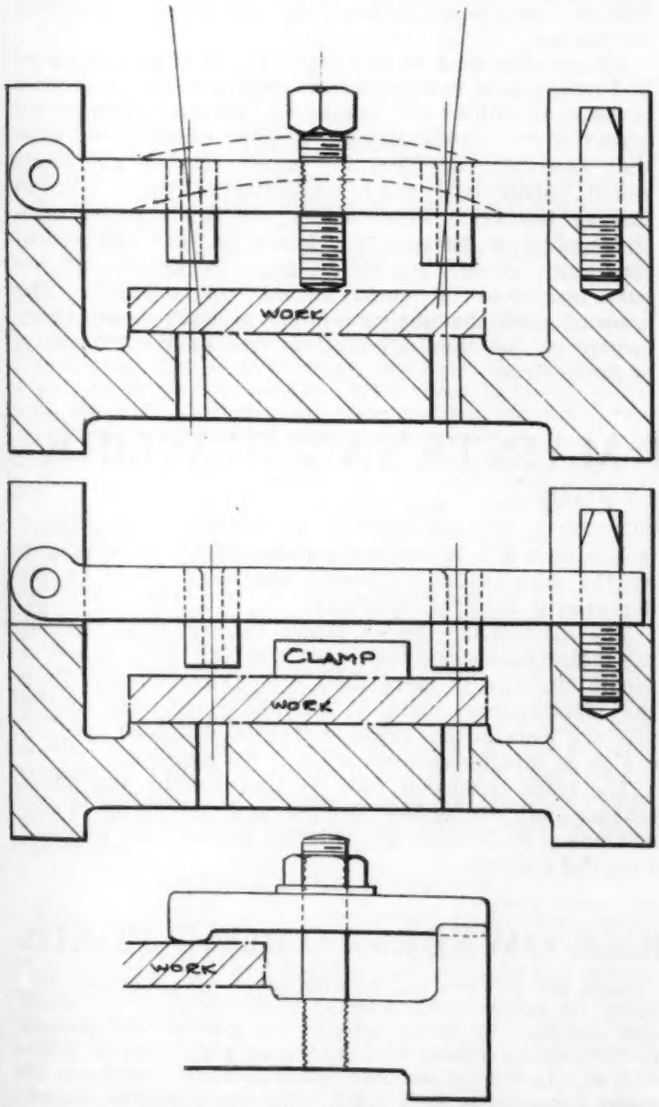

FIG. 4—EFFECT PRODUCED BY CLAMP-SCREW PLACED IN COVER
In the Design Shown at the Top, the Cover Will Spring and the Center Lines of the Bushings Will Not Be Parallel. When the Cover Holds Only the Bushings and the Clamping Is Done by a Separate Device, as Shown in the Lower Drawing, Accuracy Is Maintained

sary to design the jig body with rather heavy sections, thus making the weight so great that the jig cannot easily be moved about on the table. Under these conditions, a track or a subbase provided with suitable rollers may be used, to enable the operator to locate the jig without a great deal of effort. If holes are to be drilled in more than one plane and the weight is so great that the operator will not be able to tumble the jig easily, a suitable cradle should be provided to allow the jig to be turned to the different positions. Hardened feet of tool-steel will facilitate sliding the average drill-jig over the table, and will maintain the accuracy of the tool for a longer period.

JIGS AND FIXTURES DIFFERENTIATED

The general principles given for the design of drill-jigs will, of course, apply to milling-fixtures and similar tools. A common distinction between a jig and a fixture is that a jig is a tool that carries certain bushings or pilots for guiding the tools and, therefore, is not fastened securely to the table, though it may be guided by strips or other devices to assist the operator in aligning his work; a fixture, on the contrary, is always bolted or clamped securely to the machine-table and, in general, does not carry bushings or pilots for guiding the tools. We do, of course, have tools that are more or less a combination of these two, because of the necessity for obtaining extreme accuracy in boring, and the like. Because the fixture is fastened permanently to the machine-table, the designer need not consider the weight of the tool, except to make sure that all sections are heavy enough to give ample strength and rigidity to the tool.

When designing a fixture, it is necessary to provide suitable keys or dowels for locating it accurately on the machine-table. In milling fixtures, standard keys are used to align the tool with the key-ways in the table, thus allowing the fixtures to be removed and reset without difficulty. In some profiling-machines and other tools of a more special nature, the table is not always provided with T-slots; and it may be necessary to provide dowel-pins and cap-screws to locate the fixtures properly and to hold them securely in place.

In first-operation milling, the locating would be done in much the same manner as in a drill-jig using V-blocks, buttons or other devices for properly locating the rough material for machining. After milling one or more sur-

faces, if it has been decided to locate from these in subsequent operations, care should be taken to locate in all fixtures by the same means. With small pads a flat plate may be used; but, if the surface is large, small buttons will function just as well, and the danger of getting chips or dirt under the work will not be so great. Proper clearance should be provided, in any event, so that the operator can clean the locating surfaces easily before loading the fixture. A brush or compressed air may be used for this purpose and will probably save time and lessen the danger of spoiling some work.

A point with regard to the designing of jigs and fixtures that is not always given careful consideration when planning the operations, is the cost of the tools. In very large production, where one or more machines will be set-up to run continuously on the same operation, the accuracy and efficiency of the tool itself is of primary importance and every care should be taken to make sure that the design and workmanship are of the best. Fig. 5 shows an expensive form of construction and also a cheaper built-up design. The designer should strive to make the tool as nearly "fool-proof" as is practicable and at the same time assure uniform and accurate work. Care should be taken to eliminate all devices that call for unnecessary movement on the part of the operator, for the final cost of production is dependent on the efficiency of the tool.

Tolerance

The matter of tolerance may well be given consideration at this time, as the cost of maintaining close limits is a considerable item in tool-building. The tolerances of the part to be machined having been previously established, the tool-designer must decide what portion of this limit may be allowed the toolmaker. To send the drawings to the shop with close decimal dimensions and without working tolerances, might mean the waste of many hours on the part of the toolmaker in an effort to maintain the dimensions given. The minimum tolerance that should be allowed the toolmaker in plain-ground cylindrical or flat work would be 10 per cent of the working limits, and in the center distances between drill-bushings, and the like, at least twice this amount should be given. Care must also be taken to tie-up the various dimensions, to avoid an accumulation of errors that might produce work that would be outside the limits of the drawing.

During recent years, methods of measurement have improved so greatly that a fraction of a thousandth of an inch may be accurately measured in the average toolroom or inspection room, and this, of course, calls for close work on the part of the toolmaker. The designer should therefore study the matter of the tolerances on the tool drawing very carefully, to prevent close lapping and fitting when they are not necessary.

When the production schedule is not so heavy as that outlined, and a fixture may be required to operate for only a few days or hours at a time, it obviously would not be economical to expend so much money for tools. But whatever is built should be accurate and practical to operate.

I have attempted in this paper to cover the subject of tool design in a rather general way, but have preferred to limit myself to the classes of tool that apply to all branches of manufacturing. Specific examples of tools that have been designed for manufacturing gun parts would hardly bear much similarity to those used in making tractors. Nevertheless, the fundamental principles of good design are common to both and should constantly guide the tool-designer, regardless of the particular field in which he may be working. The accuracy and the quality of the product depend very largely on the thoroughness, as well as the ingenuity, of the designer.

ORGANIZING FOR PLANT MAINTENANCE WORK

(*Concluded from p.* 444)

machinery or equipment shall clear through the chief clerk. Meter-readings of electricity, steam, water, air and gas are sent through the chief clerk for approval and departmental distribution for the cost department.

All work-orders issued to the department foremen are kept on file until complete; this makes available at all times in the maintenance engineer's office a complete record of the work on hand that is incomplete.

A few of the records that are kept for ready reference are shown in Fig. 3. These are only digests of more complete data compiled by the different departments.

Fig. 4 is a request for authority to extend the plant and make repairs when the cost of the work to be done is less than $15, a foreman's work-order, Fig. 5, is sent by the department requesting the work direct to the department that does the work.

The maintenance order shown in Fig. 6 is used by the maintenance engineer when the cost of a change or repair amounts to more than $15. Through this form the maintenance engineer maintains splendid control over the maintenance crews with regard to how far they can go in making changes without his approval.

The plant extension form is prepared by the maintenance engineer for the purchase and installation of any machinery or for any construction project that requires a capital investment.

CONTRIBUTION OF MOTOR-VEHICLE OWNERS TO ROAD FUNDS

AN analysis of the various sources of highway funds since 1914 made by the bureau of public roads of the United States Department of Agriculture shows that a marked tendency exists to collect a larger proportion of highway funds from the owners and the users of motor vehicles. In 1914, out of a total highway income of $240,262,784, the collections from motor vehicles amounted to $12,382,031, or 5.1 per cent of the total. In 1921, 7 years later, the motor-vehicle owners and operators paid $118,942,706 in motor-vehicle fees and $3,685,460 in gasoline taxes, which together equaled 10.6 per cent of the total income for highway purposes. A similar compilation of payments made by owners and operators of motor vehicles for licenses and permits in 1923 shows a total contribution on their part of $188,970,992. In the same year gasoline taxes levied by 35 States amounted to $36,813,939. The motor vehicles, accordingly, contributed a total of $225,784,931 or 19.5 per cent of the entire 1923 highway-income. In the six New England States this contribution amounted to 25.1 per cent.—*Economic World.*

The Manufacture of Plate Glass for Automobile Uses

By J. H. Fox[1]

PRODUCTION MEETING PAPER

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ABSTRACT

GLASS was probably made first by the Egyptians and used in colored ornaments; that for glazing purposes was probably made at first by pouring the molten "metal" on to flat stones. Later, hand-blown cylinder-glass was made and this was followed by machine-blown cylinders and machine-made sheet-glass. All of these methods produce a fire-finished surface.

Polished plate-glass was made first in France. The principal process used in making it consists in melting the batch materials in pots placed in furnaces, pouring the molten "metal" on to iron tables and rolling it into a rough-surfaced plate, then annealing the plate in an oven or lehr. The rough plate is then cemented to iron tables with plaster of paris, and the surface is ground to a plane with cast-iron shoes fed with sand. After smoothing with finer abrasives it is polished with felt pads fed with rouge.

A later process is a continuous one. The batch materials are melted in a tank furnace and the molten metal is drawn or rolled from the end of the furnace into a continuous ribbon, which then passes through an annealing lehr. The sheet is cut and laid on iron tables that pass in an unbroken line under the grinding and the polishing-machines. After reversing the plates on the tables, the other side is ground and polished.

The most objectional defect in automobile glass is a wavy surface, common in fire-finished glass, or unhomogeneous metal, known as "ream." Either of these defects causes distortion of view. Other serious imperfections are poor annealing, stones, large bubbles, heavy scratches and short polish.

AS this paper is intended primarily to cover the present methods of making polished plate-glass, the time allotted will not allow a history of the development of this industry. I believe, nevertheless, that a very brief description of the evolution of the process for making both window, or sheet, glass and plate glass will be of advantage, in order that the present methods of manufacture may be made clear, the difficulties encountered may be appreciated, and the wide range in quality of the various products obtained may be fully understood.

HISTORY OF GLASS MAKING

No very definite records are extant as to when glass was first made, but evidence abounds to the effect that glass was made by the Egyptians, Phoenicians and others many centuries before the beginning of the Christian era, although its use in those early times apparently was confined largely to the making of ornaments. All glass was more or less colored, due, no doubt, to the impurity of the materials used. Certain wall paintings in Egypt, at least 5000 years old, show glass being made by hand-blowing; and it was used in windows by the Romans in the time of Nero, but its use was very limited. Beginning with the fourth or fifth century, A. D., glass was used in the windows of cathedrals to a considerable extent but was largely decorative, its purpose being to admit diffused and colored light rather than to produce clear vision. Not until about the fifteenth century was the use of glass for glazing purposes begun, in the present sense of the word.

DEVELOPMENT OF GLASS FOR GLAZING PURPOSES

The first glass used for glazing was probably made by simply pouring the molten "metal" from small pots or crucibles on to flat stones; and only small plates or discs could be made. This method later gave way to hand-blowing. In this process the raw materials were melted in pots. After gathering the viscous "metal" on the end of a blow-pipe, the glass was blown into a cylinder, which was then split, and the halves were heated to a temperature sufficiently high so that they could be unrolled and flattened on stones. Another method consisted in blowing a spherical bulb, which was then opened at one end, forming a bowl; after reheating, this bowl was rotated rapidly, the centrifugal force causing it to open out and form a flat disc. This product was known as "crown" glass. Hand-blowing methods continued to be practically the only processes used for making window-glass until about the end of the nineteenth centry. Pot furnaces for the melting of clear window-glass then gave way to continuous tank-furnaces, and more elaborate flattening ovens and annealing lehrs were developed; but in other respects the methods of blowing and of flattening the glass remained the same. Within the last 25 years, hand-blowing methods have largely given way in America to machine methods for either blowing a large cylinder or drawing a flat sheet direct. A small amount of window-glass is still made by hand-blowing in this Country and a much larger percentage in Europe.

CYLINDER GLASS

In the machine cylinder processes, the glass is drawn either from pots, into which the molten metal has been ladled, or directly from the surface of the glass in an extension to the tank furnace. A tool known as a "bait," shaped somewhat like a shallow inverted bowl and having a compressed-air connection in the center, is lowered by machinery until the rim is immersed in the surface of the glass. The bait is then slowly raised and, as the sticky viscous metal adheres to the rim, a cylinder is formed that is expanded to the diameter desired by compressed-air brought in through the top of the bait. This diameter is maintained as the drawing operation continues. The cylinders are usually drawn from 28 to 38 in. in diameter and from 30 to 40 ft. in length. After they have been lowered to a horizontal position the cylinders are cut into lengths of approximately 5 ft. and are then split and flattened in a manner similar to the methods used with smaller hand-blown cylinders. All the cylinder processes are intermittent, that is, after a

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cylinder has been drawn to a certain length, it must be melted off at the bottom. After a fresh supply of glass has been ladled into the pot, or the surface of the pool from which the glass was drawn has been properly melted down, a new cylinder is begun.

Sheet Glass

In what are known as "sheet-glass" processes, the flat sheet is drawn from the molten bath of glass either directly or through a clay slot. These processes are continuous, that is, after starting, a sheet or continuous ribbon of glass is drawn and annealed so long as the conditions in the pool will allow.

In all the processes described above for making sheet or window-glass, the surface of the sheet has a "fire-finish," formed as the glass cools, and this surface receives no further treatment after the sheet has been formed.

Manufacturing Polished Plate-Glass

Polished plate-glass was first made in France in the latter part of the seventeenth century; but since that time the processes for making it have undergone many changes, especially during the last 25 years. Until the beginning of the present century, all plate glass was made by melting the batch materials in a clay crucible or pot placed in a furnace. After the metal had been refined or "finished" and partly cooled, the pot was taken from the furnace and its contents poured or "cast" on a cast-iron table. An iron roll was then passed over the viscous mass, which was rolled into a plate, as dough is rolled into a pie crust. This plate, after cooling to a point at which it would not buckle, was pushed or "stowed" into a previously-heated annealing-oven or kiln, and the whole oven was cooled down together with the plate. At the present time, pot furnaces are still used for a very large part of the plate glass made, although within the last few years tank furnaces have been used to a limited extent. The kiln method of annealing, however, has given way almost entirely to continuous lehrs, the hot plates entering the heated end of a long tunnel and coming out annealed and cooled at the other end. This continuous-lehr method of annealing was developed by the Pittsburgh Plate Glass Co. at a very large cost, but at the present time is used by practically all plate-glass manufacturers.

The plate, as taken from the annealing kiln or lehr, is flat and uniform in thickness but has a rough surface. It is then transferred to the grinding-machine where the rough surface is first ground down to a plane surface, the high spots in the original surface being cut down to the level of the lowest indentations. This part of the operation is known as "rough-grinding" or "facing." Next, by the use of abrasives of gradually increasing fineness, this "rough-ground" surface is reduced to a very fine-ground satin-like surface, known as a "smooth." The plates are then removed to the polishing machines where the final brilliant polished surface is produced.

With this brief outline of the whole process before us, I shall now cover the successive steps more in detail, beginning with the melting-pots.

Melting-Pots

As the melting-pots for plate glass are expensive and difficult to make, have at best a short life, and their quality has a very direct bearing on the quality and cost of the glass produced, they constitute a very important item in plate-glass manufacture. They are made of carefully selected fire-clays mixed in the right proportion to give the qualities desired in the pots. It is necessary not only to have a refractory material capable of withstanding a temperature of 2600 to 2700 deg. fahr., but also capable of withstanding the chemical or fluxing action of the glass-batch materials. It is impossible to avoid some fluxing or washing action from the glass batch, but the composition of the pot should be such that this "wash" does not impair the quality of the glass. The pots must also be able to withstand great temperature-changes and severe mechanical stresses at high temperatures. At the temperatures given above the pots are white-hot and softened; nevertheless they must be tough enough to withstand the hydraulic pressure of the liquid metal. When taken from the furnace to cast the metal at a temperature of about 2000 deg. fahr., they are subject to still more severe mechanical stresses. To meet these conditions the pot-batch must be composed of a number of clays, each imparting a certain quality to the pot. Some of the clays are used raw; some are burned before mixing. Practically all clays require about 2 years' aging, after mining, before using. After careful grinding and mixing, the pot-batch is thoroughly kneaded in pugging machines and then allowed to ripen for several months before making up into pots. Usually during this ripening period it undergoes several re-puggings.

Although many attempts have been made to produce pots for melting certain kinds of glass by pouring or pressing the clay-mix into molds, the pots so made have been more or less unsatisfactory, and pot-making for the plate-glass industry is still largely a hand-operation. The pots are made with a flat bottom from 5 to 6 in. thick and with vertical side-walls usually tapering from this thickness to 4.5 or 5 in. at the rim. They are either circular or oval in horizontal cross-section, the largest pots containing about 2 tons of glass. Usually, the bottom is formed in a mold and the sides are gradually built-up by hand, a layer of clay being carefully applied each day until the rim has been fully built-up; two weeks or more being required for making the pot. As great care is required to assure uniform drying, wet cloths are used to retard the drying of parts that otherwise might dry too rapidly. After the pot has been finished it must be dried slowly for a period of several months before it can be heated. The total time elapsing between the mining of the raw materials and the completion of the drying of the pot is between 3 and 4 years. When dried the pot is placed in a furnace known as a "pot arch" and gradually brought to a temperature of from 1900 to 2000 deg. fahr. This takes several days. It is then removed from this arch while hot and placed in the melting-furnace. When put into actual service the average life of a pot is from 18 to 20 days. On account of their short life and the great length of time required to make pots, a large plate-glass plant will usually have several thousand pots in stock. This represents a large investment in buildings in which to store them, as well as in the pots themselves.

Pot Furnaces

Modern pot-furnaces for making plate glass are designed for gas fuel, although oil can be used, and are usually of the regenerative type. From 12 to 24 pots are placed in a furnace, depending upon the sizes and the proportions of the pots and upon the design of the furnace. Regenerators, consisting of well-insulated chambers lined with fire-brick and filled with loosely-stacked fire-brick arranged in checker formation, are placed under the furnace, one set under either end;

these are connected with flues and valves in such a manner that the incoming gas and the air pass through one set of regenerators, where they are preheated, then into one end of the furnace, where combustion takes place, and the waste gases pass out from the other end of the furnace into the second set of regenerators, giving up their heat to the "checker brick." At intervals of from 10 to 15 min. the direction of the flow of the gases is reversed. The pots are placed in the furnace in two rows. One of the great problems in furnace design and operation is to distribute the heat over the pots so that each pot shall be maintained at the proper temperature, the temperature of the corner pots in particular being hard to control.

Batch Materials

The raw materials from which polished plate-glass is made, known as the batch materials, are usually mixed in the following proportions, although wide variations of the mixtures are successfully used:

	Lb.
Silica sand	1000
Sodium carbonate (soda ash)	310
Sodium sulphate (salt cake)	50
Calcium carbonate (limestone)	350
Charcoal	3
Arsenious oxide	5

Broken plate-glass, known as "cullet," is also added, the percentage not being fixed. When these materials have been carefully ground and thoroughly mixed, they are placed in the pot, after it has been brought to the temperature of the furnace. As the space occupied by the loose batch-materials in the unmelted state is much greater than that of the molten glass, usually three fillings are required to fill the pot.

Pot-Furnace Cycle

Beginning with a furnace filled with empty pots at a temperature of about 2000 deg. fahr., which represents the condition at the finish of the casting of the pots, the usual cycle of a "melt" is approximately as follows:

The time required to bring the temperature of the pots in the furnace to about 2400 deg. fahr. is from 1.5 to 2 hr., when the first fill of batch materials is made. During the next 8 hr., the materials are melted down and the temperature of the furnace is raised to about 2650 deg. fahr., when the second fill is made. The furnace is held at this temperature and, at the end of another 2 hr., a third fill is made. Continuing at a temperature of 2650 deg. fahr. for 3 hr. more, the third fill is melted down and the metal is refined. At this temperature the gases rise to the surface much more readily than at lower temperatures, owing to the greater fluidity of the glass. During a further period of from 5 to 6 hr. the temperature is gradually reduced to about 1900 deg. fahr. by shutting off the fires. The fires are then increased again, bringing the temperature up to about 2000 deg. fahr. in 1 hr., and at this temperature the pots are taken from the furnace, one at a time, at intervals of from 6 to 8 min.

Casting the Metal

A power-driven crane, from which is suspended a pair of tongs that grasp the pot, is used for taking the pot from the furnace. After the bottom of the pot has been carefully cleaned with wire brushes and all the surface dirt has been blown from the bottom and sides with compressed air, the metal is cast on a water-cooled iron table.

The usual American practice is to use a separate crane for casting the pot, or "teeming," as it is called, from the crane that is used in taking the pot from the furnace; but in many European plants the same crane is used for both purposes.

The casting-table is made in sizes up to 22 ft. in width by 30 ft. in length and is built-up of water-cooled sections from 12 to 18 in. wide but extending the full length of the table. These are keyed and bolted together in such a manner that they assure accurate cross-alignment under varying temperature-conditions. The glass is poured across one end of this table against a water-cooled cast-iron roll, which is then rolled the length of the table, pushing a wave of molten metal in front of it and rolling the glass into a plate. The thickness of the plate is determined by the thickness of two bars of steel, known as "trams," that are placed on either side of the table and carry the weight of the roller. As soon as the plate has cooled to a temperature that will allow it to be pushed from the table without buckling (about 1100 deg. fahr.) an electrically-operated device, known as a "stowing tool," is used to push it quickly into an oven that has been heated to a temperature of about 1180 deg. fahr. Great care is required in casting to avoid producing a wavy surface on the glass, if it is cast too cold, and to avoid fire-cracks being formed on the under surface of the glass, if it is allowed to lie too long on the comparatively cool table. Fire-cracks are shallow cracks that penetrate but little below the surface.

Annealing the Plates

When the plate is pushed into the first oven, the temperature of the bottom of the plate is lower than that of the top; it is necessary, therefore, to keep it in a uniform soaking-heat for some time to equalize the temperatures and the stresses.

In a standard annealing-lehr five ovens are provided, through which the plate is moved successively before entering the tunnel or body of the lehr. The temperature in the second oven is held at approximately 1200 deg. fahr. In the third, fourth and fifth ovens this temperature is gradually lowered to about 1100 deg. fahr. The floors of these ovens are made of carefully cut clay blocks that must be in perfect alignment, especially in the fifth or last oven where the plate takes its permanent set. At a temperature of approximately 1100 deg. fahr. the glass becomes sufficiently solidified so that it can be stowed on longitudinal bars from 12 to 14 in. apart without sagging. It is then gradually moved the length of a long annealing and cooling chamber by means of two sets of bars, one stationary, the other movable. The movable bars rise between the fixed bars, lift the glass, carry it forward down the lehr, then lower and disappear between the fixed bars for the return stroke, leaving the glass resting on the fixed bars. The length of this annealing-chamber or tunnel is dependent upon the thickness of the glass to be cast, the rate of casting and the size of the plate, and varies from 200 to 600 ft. For a rough plate of the ordinary thickness, which is slightly less than ½ in., the total time spent by the plate in the lehr is from 3 to 3.5 hr.

Examination and Cutting of Rough Plates

At the cold end of the lehr, the glass is examined in a darkened chamber, into which some light is admitted under the plate, and is marked for the larger defects that can be seen in the rough plate. The plate then passes from the end of the lehr at a temperature but slightly above that of the air in the building, and moves

automatically on to the rough-cutting table. Here the plate is cut into sizes that will eliminate the defects that the examiner at the end of the lehr has indicated with chalk-marks. These cut plates are then removed to the rough racks by cranes from which are suspended either rubber-lined clamps that grip the glass, or suction frames that are provided with a number of circular cup-shaped rubber discs. When these discs have been placed in contact with the surface of the plate and the air has been exhausted. the plate can be picked up by suction.

The Grinding and Polishing Tables

From the rough-glass racks the glass is then taken by other cranes to the "laying-yard," where it is cemented to the surface of the grinding and polishing tables by a thin film of plaster of paris. The grinding and polishing tables are circular and vary in size from a few feet to 36 ft. in diameter. As it is essential to maintain as nearly perfect a plane as possible on the surface of these tables, they must be made very rigid and be accurately machined. They are mounted on four track-wheels for convenience in moving them about the plant. The powdered plaster is mixed with water into a thin paste, which is spread over the surface of the table with a wave motion, and the plate is lowered with one edge resting on the table in advance of the other edge, so that as the glass is lowered into a horizontal position the plaster is carried forward and squeezed from the under side of the plate, carrying air bubbles with it and leaving as thin a film of plaster as is practicable. A squad of men then float the plate into position and tramp it down to assure contact at all points. After allowing the plaster to set for approximately 30 min., the table is moved to the operating position in the grinding-machine by means of the track wheels alluded to above.

Grinding

The driving-mechanism of the grinding-machine, which is entirely below the working-floor level, consists of a heavy vertical shaft provided with a spider at the upper end that engages the center of the under surface of the table. This vertical shaft is raised by hydraulic or other means and lifts the table from its track; the shaft and table are then rotated by an electric motor, acting through proper reducing-gears. On an overhead frame are supported two circular discs, known as "runners," to the lower faces of which are secured a series of cast-iron "runner-blocks" adapted to distribute the abrasive on the surface of the glass. The abrasive passes between the lower surfaces of the blocks and the glass. The supports of the runners are such that the runners can be readily raised or lowered and the pressure on the glass accurately controlled. This is accomplished either by floating them on hydraulic pontoons or by balancing them with springs or counterweights. The runners are mounted on vertical shafts provided with suspension and thrust bearings. In circular machines they usually are not rotated by a direct power-connection but are simply floated on the rotating table. This arrangement causes the runners to be driven by the table and to rotate, when in action over the table, at a speed depending on the manner of feeding the abrasive and on the adjustment of the runners. When grinding, the table rotates at a speed of from 20 to 30 r.p.m. depending on the size of the table. Sand that has been screened through a 12 or 14-mesh screen is washed on to the table and acts as an abrasive until the glass has been faced, after which the table is washed off and carefully graded sands of gradually increasing fineness are fed on to the table until the requisite fine grind is obtained. The table is again washed off and several grades of emery, ground still finer, are applied, producing a very fine grind, or a "smooth."

In the grinding process some breakage of glass is liable to occur and some plaster may become loosened in the joints; the table is therefore removed from the grinding-machine to what is known as the "jointing-yard," in which workmen clean the table, repair the joints with new plaster, and remove and replace badly broken glass. After a further period of 20 min. or more, for the setting of the plaster, the table is moved to the polishing-machine.

Polishing

The driving-mechanism of the polishing-machine is similar to that of the grinder but, instead of two runners, from four to six runners are usually suspended above the table, each runner being provided with a large number of separate felt pads. In this Country, these pads usually are from 18 to 20 in. in diameter; the European practice is to make them somewhat larger. The pads are made of a special hair felt about ¾ in. thick, fastened by rings to cast-iron discs, which are attached to the runner by flexible sliding connections, allowing each pad to float on the table independently of the other pads. The polishers rotate from 10 to 20 r.p.m., depending on their size, and are supplied with a mixture of very carefully prepared red oxide of iron or "rouge," suspended in acidulated water that is fed on to the surface of the glass at the proper points to keep the felt pads faced with it and to produce the proper polishing action.

From 1 to 1.5 hr. is the time required for the grinding operation, and from 1.25 to 2 hr. that for the polishing operation, both depending on the size of the machines and various other conditions.

The total amount of power, measured in kilowatt-hours per unit of glass surface, that is required for polishing is practically double that required for grinding and, in the grinding of glass of fairly uniform thickness, the facing takes less time than does the producing of a "smooth" after the glass has been faced. I am calling attention to this for the reason that many persons have an exaggerated idea regarding the difference in cost between the grinding and the polishing of a very flat plate of uniform thickness that requires the removal of but little glass, and the grinding and the polishing of a plate from which more glass must be removed. In either case, it is necessary to remove the fire-finish surface; the smoothing and polishing operations are the same, so that the only reduction is in the facing. There is, of course, a reduction in the amount of ground-off metal that is thrown away, in the quantity of coarse abrasive that is required, and in the power required for facing, but these do not affect the total cost to the extent that is popularly supposed.

After grinding and polishing one side of the glass, the table is removed to what is known as the "turnover-yard," where the glass is lifted from the table and reversed, with the finished side down. The usual American practice is to lay the glass on plaster for the second side as well as for the first. The European practice is to lay the second side on a soft cloth and then fill the joints and edges with plaster. This latter practice reduces the amount of plaster required but adds to the labor of laying and, as the final results obtained are the same in both cases, the practices in this Country and in

Europe merely reflect the relative costs of labor and of material on the two Continents.

After the turnover, the second side passes through the same cycle of grinding and of polishing operations as the first. The tables are then moved to the "stripping-yard," where the glass is lifted from the tables by cranes equipped with either clamps or suction-frames, is carried to the wash-racks and, after being thoroughly cleaned with water and dried, is moved to the examination racks, where it is examined carefully for defects, and is cut to the best advantage to eliminate these defects. It is then taken to the packing-room and carefully boxed for shipment. Layers of soft heavy paper are placed between the plates to prevent the marring of the polished surfaces, and hay or straw is used to pad the inside of the boxes.

Continuous Process For Making Polished Plate-Glass

The latest development in the manufacture of polished plate-glass includes continuous processes, not only for making the rough plate, but also for grinding and polishing it into the finished product.

The mixed batch-materials are fed at regular intervals into the melting end of a continuous tank-furnace. The molten metal is refined as it slowly moves down the tank and then flows from the end into a chamber from which it is either drawn or rolled into a continuous ribbon or sheet of glass. This ribbon then passes through an annealing lehr, entering at a temperature of about 1200 deg. fahr., and leaving at a temperature of about 100 deg. fahr.

It passes next through the examination room, where the defects are indicated with chalk-marks, and then moves to the cutting-table, where it is cut into lengths convenient for laying on the grinding and the polishing-tables, the defects being eliminated so far as possible. The tables are rectangular in form and are mounted either on carefully turned track-wheels that travel on accurately aligned rails, or on shoes sliding in ways similar to those of a metal planer. The ends of the tables maintain contact when in action under the grinding and the polishing machines and present a continuous surface. The rough glass is laid on these tables, usually in plaster, although cloth or other means can be employed. After the proper period for the setting of the plaster has elapsed, the table passes under a row of grinding-machines, the successive machines being fed with the various grades of abrasive required for facing the glass and then for producing a "smooth."

After leaving the grinders, the table passes through a "jointing-yard," where workmen repair the bad joints with plaster and replace any badly broken glass. It then continues under a row of polishing-machines, the runners of which are provided with blocks shod with felt pads similar to those used on the older-type circular machines. The runners of the grinder and the polisher are rotated by electric motors, for the motion of the table is too slow to produce an appreciable grinding or polishing action from this movement alone. After leaving the polishers, the glass is turned over and relaid with the finished side down. It then passes through a second line of grinding and polishing-machines and undergoes the same treatment as for the first side. The table then moves into the stripping-yard where the glass is lifted and passed to the wash-racks and cutting-tables.

Returning to the beginning of this continuous process, the batch materials may be stored in bins of any form that are provided with elevators for unloading these materials from cars conveniently and economically. They are usually elevated so that a weighing and mixing car can pass under them and draw off the materials directly into it. After mixing, the materials are carried through a system of elevators and conveyors to a bin directly over the melting end of the tank furnace. Charges of batch are drawn from this bin and dumped into the end of the furnace at intervals of about 20 min., the weight of the charge depending upon the rate at which the molten metal flows from the opposite end of the tank, for it is essential that a constant level of glass be maintained in the tank.

Tank Furnace

The body of a tank furnace consists of a reservoir from 3 to 5 ft. deep, and with a great range as to width and length, the largest having an inside width of about 32 ft. and a length of 140 ft. When in operation this reservoir is filled with molten glass to within about 2 in. of the top. The bottom and the side walls are built-up of burnt-clay blocks, the bottom being usually about 12 in. and the side walls from 12 to 24 in. thick. An arched crown of silica brick is sprung over the basin and, at the melting end, ports are provided on either side above the glass line, for admitting the fuel gas and the air and for carrying off the waste gases.

Regenerators similar to those described above for the pot furnace are provided, but they are built on either side of the furnace instead of under it, as is usual in pot furnaces. It is essential that free circulation of air under the tank as well as along the side walls be provided, to prevent the blocks from becoming overheated and from wearing away too rapidly. For this reason, as well as for certain constructional reasons, the regenerators are not placed under the tank. The construction of the refining end of the tank depends upon the particular process that is used for forming the sheet. In operating the tank furnace the direction of the flow of air and fuel gases is reversed at intervals of about 20 min. As the temperature conditions in a tank furnace are practically constant, waste-heat boilers, or other means of utilizing the heat in the waste gases when they leave the regenerators, are more practicable than they are in a pot furnace.

Although Sir Henry Bessemer, three-quarters of a century ago, rolled glass into a continuous sheet as it was drawn from a furnace, it is only recently that this process has been reconsidered in the production of plate glass, and it is not yet known how far it can supersede the older processes.

Annealing Lehr

In the lehr used for the continuous rolling or drawing processes for sheet glass, the reciprocating bar arrangement for moving the glass along the lehr, that is ordinarily used in annealing separate plates, is not practicable. In place of the bars, rolls running crosswise of the lehr are used. These are rotated at a uniform speed and carry the ribbon of glass forward continuously.

Quality

In practically all articles of manufacture, other than plate or sheet glass, quality is determined largely by appearance, namely, the color or form, something definite and positive that can be seen. In polished plate-glass, however, the highest quality is represented in a product that is practically invisible. Perfect quality in polished plate glass, therefore, means the absence of everything that can be seen, and is negative. The quality of plate

glass can be judged only by the absence of visible imperfections.

Imperfections in Plate Glass

The imperfections that appear in plate glass can be divided into two general classes: (*a*) those in the metal, and (*b*) those in the surface.

The following terms are used to describe these imperfections in the metal.

Ream.—An area of unhomogeneous glass causing irregular refraction of the light-rays and producing a wavy appearance.

Stones.—Opaque particles included in the glass, consisting of unmelted batch-materials, clay from the furnace or pots, devitrified glass, or foreign material introduced accidentally into the glass.

Strings.—Thread-like transparent lines incorporated in the metal, caused usually by small stones that are melted and drawn out but not reduced to the same optical density as is the body of the glass.

Bubbles.—Gas inclusions in the glass, usually spherical in rolled glass. The term bubble is generally applied to inclusions larger than 3/32 in. in diameter.

Boil.—A term usually applied to small bubbles between 1/32 and 3/32 in. in diameter.

Seeds.—Minute bubbles less than 1/32 in. in diameter. Seed between 1/64 and 1/32 in. is usually spoken of as "coarse"; that under 1/64 in. as "fine."

Skim.—A term applied to streaks of dense seed and small bubbles.

The following terms are used to describe imperfections in the surface.

Open Bubbles.—A term applied to bubbles partly cut away in the grinding and polishing operations, leaving an open pit.

Fire-Cracks.—Short shallow cracks that penetrate the surface of the sheet, usually caused by excessive chilling of the surface.

Sand-Holes.—Isolated indentations in the surface caused by coarse grains of sand becoming mixed with the finer grades in the smoothing operations and not removed by the smoothing and polishing.

Sleeks.—Very fine hair-line scratches.

Scratches.—Any marking or tearing of the surface.

Short Smooth.—An area of grayish surface caused by lack of a proper smooth before beginning the polishing operation.

Short Finish.—Insufficient polish or lack of brilliancy.

Quality Desired in Automobile Glass

The most important quality that is desired in automobile glass is clear vision without distortion. A defect in the windshield that distorts the view of the road ahead, or misplaces the location of an approaching car or any object on or along the road, is far more serious than a defect that does not interfere with clear vision. Although not so vital for safety as it is in the windshield, the avoidance of distortion of view in the side and rear lights of a car is very desirable. This distortion is much more apparent and disagreeable in a moving window, such as that of an automobile or a railroad coach, than in a stationary one. Every one, no doubt, has looked through a wavy sheet of glass in the window of a moving railroad car and has watched the rails of parallel tracks apparently waving and writhing like snakes. This distortion is produced either by unhomogeneous glass having a varying refractive-index and, therefore, causing the rays of light to bend in the body of the glass, or by a wavy surface that causes the rays of light to be deflected irregularly at the surface of the glass. In polished plate-glass, as the surfaces are machine-made and are cut to practically perfect planes, the distortion caused by a wavy surface cannot occur. Lack of homogeneity of the glass, known as "ream," is the only defect in polished plate-glass that can cause distortion; and this is very slight when compared with the distortion produced by a wavy surface in fire-finished window-glass.

In fire-finished glass, not only is ream possible, but it is practically impossible to make the glass free from a wavy surface, the question being merely one of the degree of waviness. The waviness in the best sheet-glass may not be apparent to a person looking through the sheet in a direction at right angles to the surface, but it becomes apparent at flatter angles and is conspicuous in reflected light.

With reference to the other imperfections in the glass that are given in the above list, stones, large bubbles, skim, and long or heavy scratches should not be allowed. Stones are especially objectionable, for cracks are liable to start from them. A defect of any kind is not so objectionable in the edge as in the central part of a plate. Defects, such as seed, boil, light surface-scratches and light strings, that have been removed from the central part of the plate, are not noticeable when an object is viewed through the glass. It is therefore a mistake to apply too high a standard to automobile glass, with reference to certain very minor defects, or to apply the same standard to it that would be applied, for instance, to a high-grade mirror. The conditions, especially with reference to light, under which glass is examined, have a large bearing in detecting minor defects. When examined minutely in strong sunlight at the proper angle and with a dark background, a plate of glass can rarely be found that is free from all defects, especially very fine seed. To carry specifications too far in this respect would therefore increase the cost of the glass, with no corresponding advantage to the ultimate purchaser.

It is practically impossible, by any known process, for all the product from a factory to have a given quality, even when the greatest precautions are taken in all parts of the process. In the production of high-grade optical glass, of which only the best quality can be used and for the production of which every precaution is taken to assure as high a percentage of this quality as is possible, only 15 or 20 per cent of the glass produced can be used, the rest being thrown away. In the regular product of plate-glass plants, the percentage of first silvering-quality is very small; one can easily conceive, therefore, a condition in which the demand for this quality might exceed the total production of it from all the existing plants.

By using special precautions some increase in the percentage of silvering quality glass might be effected but, judging from the experience with optical glass, the total percentage of it even then would be only a fraction of the total production. To operate a factory, with the express purpose of producing as large a percentage of the silvering-quality glass as possible, would greatly increase the operating cost per square foot of the glass produced. As this additional cost must be borne by the silvering-quality glass, its price would be prohibitive.

Thickness Specifications

From the description given above as to the methods employed in grinding and polishing glass, it is evident that some leeway must be allowed in the thickness of the finished plate. It is possible to grind and polish glass to a definite thickness, but this adds greatly to

the cost and therefore is only practicable in a very high-grade product for optical instruments.

As practically no metal is removed in the polishing and very little in the smoothing operations on the grinder, the final thickness of the plate is determined by the facing.

In the facing of the rough plate, the operation is continued only until the lowest indentation in the surface has been removed; and this can be judged by the appearance of the surface of the plate. Although the rough plates are fairly uniform in thickness, it is not possible to maintain the rolling and annealing equipment in such a state of perfection that absolute uniformity in a rough plate can be assured, nor is it possible to maintain such perfection in the grinding-machinery without excessive refinement. To face to an exact dimension as to thickness would therefore require interruptions in order that measurements might be taken during the facing operations and a degree of refinement would be required throughout all the processes that would add enormously to the cost.

Sizes of Plates

In most lines of manufacturing it is of great advantage to make a very large number of pieces of the same dimensions in order that they may be produced at the minimum cost. If plate glass that is absolutely free from all objectionable defects in the metal could be produced and it could be ground and polished without breakage, the above might apply to this industry. Under existing conditions, however, which make it necessary to cut the glass largely to eliminate defects, it is of decided advantage, in keeping down the cost of production, to have orders for many different sizes. This feature applies not only to polished plate-glass, but also to window-glass.

Strength of Plate Glass

Questions are often asked regarding the tests that can be applied with advantage to polished plate-glass to determine its strength. It is evident to everyone that a glass for use in automobiles, that will withstand as great a shock as possible without breaking, is desirable, and that, when it does break, as little damage as possible shall be done. The discovery of the long-sought-for unbreakable glass would be a great boon to automobile users, if it could be produced cheaply enough and if it possessed, within reasonable limits, the optical and other qualities desirable in glass for this use. The usual tensile and compressive tests of the glass at present available do not bring out the qualities most desirable for the use in question.

The annealing, or what might more properly be termed the tempering, of the glass plate, plays an important part in determining its break-resisting qualities. A well-tempered plate, even though it may possess lower tensile and compressive strength, is much more desirable than is a poorly tempered sheet having a higher test-strength. The apparently stronger plate may not withstand shocks as well as will the softer plate, and when it does break it is liable to fly into many more pieces.

If the plate is cooled too slowly through a certain range of temperature, the glass becomes soft and lifeless and is described by glass-workers as "rotten." If cooled too rapidly through this range of temperature, it becomes hard and brittle. When the surfaces of the plate cool too much in advance of the center, extremely high compressive stresses in the surfaces of the plate and tensile stresses in the center are set-up, causing the plate to break readily, especially if the surface is broken, and the stresses become unbalanced.

In a properly tempered plate a midway condition exists, moderate tensile stresses being in the center of the plate and moderate compressive stresses in the surfaces. As the crushing-strength of glass is several times its tensile-strength, it is evident that, as a beam, its resistance is greater when the initial compressive-stresses exist in the two surfaces. When a load is applied, normally to the surface of the plate, the first effect is to reduce the compressive stresses in the lower chord, or the tension side, of the beam to zero, then to change them to tensile stresses as the load is further increased. In the top chord, or the compression side, of the beam, the initial compressive-stresses are added to or built up from the beginning of loading, so that the final resultant compressive-stresses in one side of the beam are much higher than the final tensile-stresses in the opposite side, which is a desirable condition in a material having the relative tensile and crushing-strengths possessed by glass. It is important that the temper be the same on both sides of the plate and uniform throughout its area. Changes in the batch with a view to increasing the strength of the glass usually result in greater difficulty in refining the metal in the furnace and, therefore, in a larger number of imperfections in the metal.

Great care should be exercised to avoid distorting the plate when mounting it in its frame. This distortion not only reduces its resistance to breaking, but also distorts the view through it, if the bending is appreciable. It is also important that the edges of the plate be smoothly finished, for cracking or chipping frequently begins at a ragged edge.

Salvage of Waste Glass

In the salvaging of waste plate-glass no difficulty has been experienced in recutting the glass to any size desired, the chief obstacle being the restoring of the marred surfaces; and the problem presented is, how far it will pay to go in restoring these surfaces. When the finish has been dulled, or even when it contains very slight scratches, known as "sleeks," the surface can be restored at a moderate cost on a repolishing-machine, and with the use of comparatively inexpensive equipment. When the scratches are deep, and require the removal of an appreciable amount of metal for their elimination, it is necessary to regrind the surface and then polish it; and the cost of doing this with small equipment is usually prohibitive.

In the manufacture of polished plate-glass many difficulties are presented. Not only are the surface of the product subject to close scrutiny and its strength and weathering qualities subject to test but, by reason of its transparency, the most minute internal defect is visible. This is a condition that does not apply to the manufacture of any other construction-material. In making even slight changes in the methods of manufacture, to correct one set of defects, the great danger is always present of introducing defects of another kind, as in the case cited above, namely, a change in the batch to increase the strength of the glass is liable to introduce defects in the metal.

The production of a plate-glass plant is very small when compared with the size of the plant that is required and the amount of capital invested. About 20 tons of raw materials, fuel, abrasive, plaster, and the like, as well as batch materials, are required for every ton of the finished product, and the daily output of one of the largest plants, representing an investment of many millions of dollars, is only two or three carloads.

Tool Salvage

By L. A. CHURGAY[1]

PRODUCTION MEETING PAPER *Illustrated with* PHOTOGRAPHS AND CHARTS

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

RECLAIMING worn-out or rejected tools represents but a part of the work of a tool-salvage department. Many tools become obsolete due to engineering changes in the product and to changing the manufacturing methods. Surplus tools represent tied-up capital and to adapt these tools to changed shop requirements or dispose of them at a fair approximation of their original value requires careful planning.

All worn, broken and obsolete tools should be kept in separate containers; to throw them into a common scrap-box necessitates expensive resorting. Tool-crib attendants usually are directly supervised by the central-stores department.

Standard forms of purchase and inter-department requisitions are described and their usage specified. The men employed in this reclamation work are trained as specialists in operations such as welding high-speed steel tool-bits to carbon-steel shanks, and the like. They are classified as blacksmiths, heat-treaters, welders, machinists, tool makers, emery-wheel cutters, grinders and bench men. Details of tool-reclamation work follow.

As stated by the author, the salvage department is not organized to attempt to set a basis for an accurate percentage of new-tool expense saved by the use of reclaimed tools. Its ultimate purpose should be its functioning with the least possible friction and the rendering of the most effective service to all other departments.

FIG. 1—TOOL-RECLAIMING SHOP
The Machines Used In Salvaging Drills, Reamers, Wrenches, Braces, Milling Cutters and Other Tools Indicate the Completeness of the Reclamation Equipment and System

SALVAGING perishable tools has become of more than ordinary importance during the last decade, because of the increasing costs of material and labor and the necessity for economizing. The value of the tools salvaged and the prompt service the salvage department renders in supplying reclaimed standard or special tools on short notice shows that, when measured in dollars and cents, this department has an important part in the present-day tool-organizations. The functions of tool salvage are not limited necessarily to reclaiming worn-out or rejected tools. Due to engineering changes of the product and to changing the manufacturing methods, many tools become obsolete. A careful survey of the tool-supply stores frequently discloses a surplus of tools that represents a considerable amount of tied-up capital. To adapt these tools to shop requirements, or to find an outlet for them at somewhere near

TABLE 1—DAILY SCHEDULE OF SALVAGE DEPARTMENT

Quantity	Name	Tool Number	Disposition	Tool Number	Company Work-Order Number
4	6 x 1 x 1¼ in. H. S. Side Milling Cutters	37,205-T-1	5¾ x ⅞ x 1¼ in. H. S. Side Milling Cutter	33,138-T-4	43,076
24	⅝ in. T. S. H. S. Reamer	6,082-T-3	9/16 in. T. S. H. S. Reamer	3,319-A-T-3	42,465
12	4 x ⅛ x 1 in. N. S. Slitting Saws	32,001-T-6	3¾ x ⅛ x 1 in. H. S. Slitting Saws	32,001-T-6	43,250
24	1⅛ in. H. S. Counterbores	10,030-P	1 1/16 in. H. S. Counterbores	10,031-P	39,607
12	¾ in. T. S. H. S. Drills	.....	Regrind Taper and Remill Tang	.....	39,760
24	33/64 in. T. S. H. S. Drills, Clearance Worn	.....	Reduce to ½ in. T. S. H. S.	.....	38,620
12	Speed Socket-Wrenches	10,401-P	Weld New Heads on Same	10,401-P	37,500
12	6 x 1 x 1 in. Turning Tools	32,008-T-6	Weld Stellite Tips on Same	32,008-T-6	37,601
12	8 x 1 x 1 in. Turning Tools	33,138-T-3	Weld Stellite Tips on Same	33,138-T-2	37,602

[1] Engineer, production division, Maxwell Motors Corporation, Detroit.

MAXWELL MOTOR CORPORATION
INTER-DEPARTMENT REQUISITION NO. _____
STOREKEEPER WILL NUMBER CONSECUTIVELY

PLEASE DELIVER MATERIAL LISTED HEREWITH TO DEPT. Central Stores
CHARGE DEPT. NO. / ACCOUNT NO. 70 CR. DEPT. NO. / ORDER NO. / ACCOUNT NO. C-87 DATE 9/2 1924
SPECIFY INTELLIGENTLY WHAT YOU WANT. WRITE SO IT CAN BE READ. DON'T OVER ORDER. RETURN WHAT YOU DON'T NEED. KEEP OUT OF PRICE COLUMN

QUANTITY ORDERED	QUANTITY DELIVERED	LBS. FEET DOZEN	PART NUMBER IF ANY	DESCRIPTION	PRICE	AMOUNT	BALANCE IN STOCK
200	100		50441-T-15	A. S. Cutter Blades @	1 35	185 00	
6	6		A-8344-R-1	Arbors @	4 00	8 00	
80	80		35841-T-2	.500" Dia. H. S. Reamers @	1 50	90 00	
150	150		15/32"	Dia. H.S. Taper Shank Drills @	54	81 00	
50	50		6"x1/2x1/2	#3846-L Saucer Shape Wheel @	1 02	51 00	
				Requisition No. 2844			
				C. W. O. 37490			

DATE
DELIVERED 9/5/24 ORDERED BY _____ FOREMAN
RECEIVED IN REQ. DEPT. _____ DELIVERED BY _____ STOREKEEPER

FIG. 2—INTER-DEPARTMENT REQUISITION-FORM
These Are Made in Duplicate, One Copy Is Retained by the Salvage Department; the Other Is Sent to the Central-Stores Department

their value requires careful planning and good execution. Table 1 is an example of the daily schedule of the salvage department, and the tool reclaiming shop is shown in Fig. 1.

ORGANIZATION AND PROCEDURE

Worn and broken tools are of little interest to the average tool-crib attendant and, unless instructed to keep the various replaced tools and supplies in separate containers provided for this purpose, all drills, reamers, milling cutters, files, wrenches, hammers, high-speed steel and stellite tool-bits, brushes, grease cans, gloves and the like are thrown into the common scrap-box and sent to the tool-salvage department to be segregated. This entails considerable expense. Tool salvaging having been introduced as an economic measure, it is hardly conceivable that such procedure is in accordance with the principle involved.

The tool-crib attendants throughout the shop usually are under the direct supervision of the central-stores department. They receive their instructions from this department for the taking care of new tools, as well as in regard to how to handle and dispose of the accumulated broken and worn-out tools.

Ordinarily, a standard form of requisition is issued by the department foreman for the replacement of worn-out tools. These requisitions are forwarded daily by the crib man to the central stores. They are listed according to departments, the cost is entered for each item and the amounts are totaled. Copies of these reports are then forwarded to the various departments interested in this transaction.

To keep the salvage department in constant touch with current tool needs and to enable it to dispose of the accumulated supply, all purchase requisitions for new perishable tools are issued in triplicate by the central-stores department. Of this form one copy is retained for file and two copies are forwarded to the salvage department. On receipt of these requisitions, the salvage department makes an effort to fill in all items so far as possible,

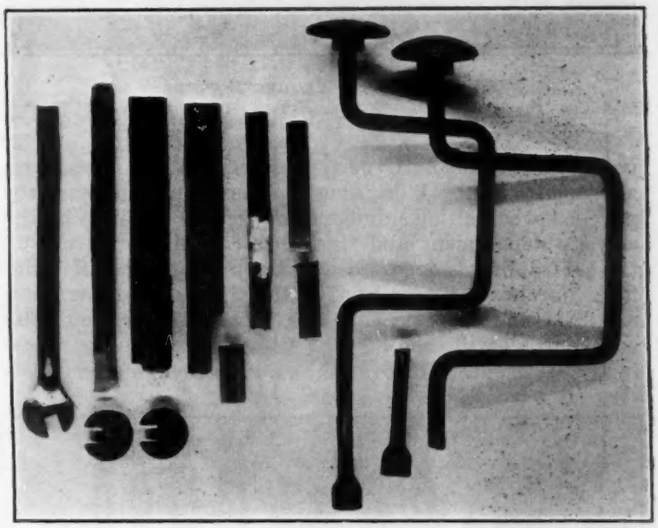


FIG. 3—SALVAGED TOOLS
Those Shown Include Stellite Tips Welded to Carbon-Steel Shanks, Wrenches, Braces, and Turning Tools

TABLE 2—WEEKLY SALVAGE DEPARTMENT REPORT

The following Tools have been supplied to Central Stores on Purchase Requisitions for the Week Ending Aug. 15

Quantity	Description	Requisition Number	Price Each	Price Total
2	1 21/32 in. H. S. Four-Lip Shell Core Drills	2,010	$4.60	$9.20
10	¼-20 Two-Flute Gun Drills	2,043	0.30	3.00
8	1 5/16 in. T. S. H. S. Drills	2,036	5.80	46.40
1	⅜ x 1 in. Diameter H. S. Hollow Mill	2,041	1.50	1.50
1	25/32 in. T. S. H. S. Reamer	2,060	2.20	2.20
1	½-18 Round Adjustable Button Die	2,062	0.85	0.85
13	1¼ in. H. S. Eclipse Counterbores	2,079	6.30	81.90
200	7/16-14 No. 3 Flute Gun Drills	2,082	0.45	90.00
3	7/16-20 Round Adjustable Die 1½ in. O. D.	2,085	0.65	1.95
6	2¼ in. Fig. 25 McCrosky Adjustable Shell Reamers	2,078	20.50	123.00
9	1 in. 60 deg. H. S. Countersinks	2,083	1.00	9.00
8	2 in. Fig. 25 McCrosky Adjustable Shell Reamers	2,090	18.50	148.00
33	23/32 in. T. S. H. S. Drills	2,092	1.45	47.85
274	No. 47 S. S. H. S. Drills	2,076	2.18[a]	50.00
1 Set	⅜-16 9/16-in. Diameter Geometric Die Chasers	2,093	5.00	5.00
12	6 x ¾ x 1¼ in. H. S. Side Milling Cutters	2,172	16.00	192.00
18	4 x ¾ x 1¼ in. H. S. Side Milling Cutters	2,106	10.35	186.30
12	10,215-F-1 Socket Wrenches	9,564	3.50	42.00
12	A-5,555-F-62 Socket Wrenches	9,538	5.50	66.00
172	No. 4 Rawhide Faced Hammers	9,542	0.75	129.00
84	No. 4 Brass Hammers	9,548	0.35	29.40
3	Bench Vises	9,570	8.00	24.00
162	No. 3 Lead Hammers	9,576	0.25	40.50
			Total	$1,329.05

[a] Per dozen.

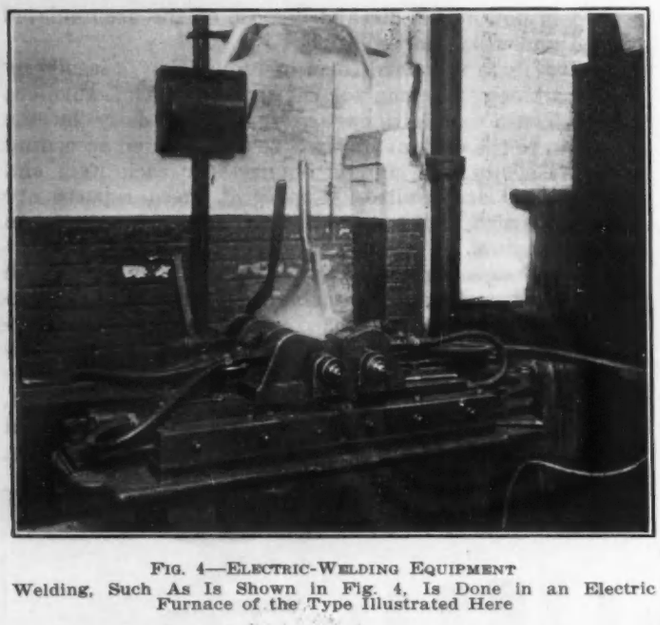


FIG. 4—ELECTRIC-WELDING EQUIPMENT
Welding, Such As Is Shown in Fig. 4, Is Done in an Electric Furnace of the Type Illustrated Here

using an inter-department requisition of the form shown in Fig. 2. It is issued in duplicate and bears the purchase-requisition number; one copy is retained by the salvage department and the other copy is forwarded to the central-stores department. Upon comparing the original purchase requisition with the inter-department requisition, the items that the salvage department was unable to fill will then be requisitioned from the purchasing department. To cover the cost of salvage operations,

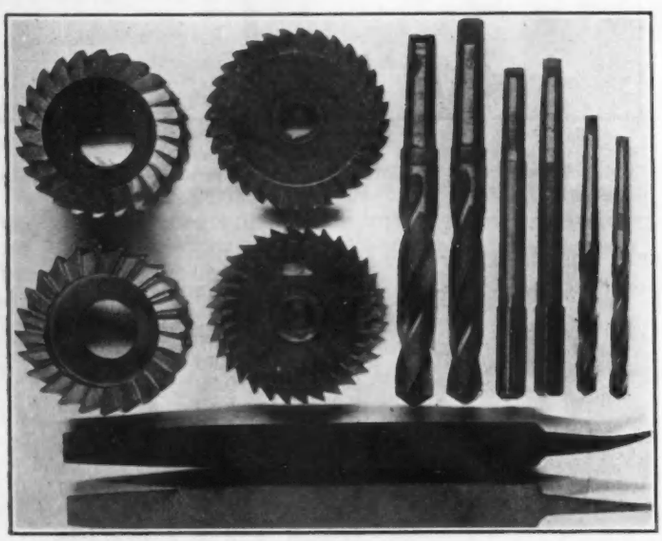


FIG. 5—OTHER TYPES OF SALVAGED TOOLS
Milling Cutters, Drills, Reamers and Files Are Other Examples of Tools Put Through the Reclamation Process and Made As Good As New

company "work orders" are issued and the numbers of these orders are entered on the inter-department requisitions.

PERSONNEL

The man in charge of tool salvage must have a broad, practical knowledge of the various tool and high-speed steels and their treatments, of the possibilities of welding and of the methods of grinding. He must possess considerable enthusiasm and constructive energy for this particular work and have also good sound judgment in directing his efforts so that real economies are effected and tools are salvaged at reasonable costs. Table 2 is an example of a weekly salvage-department report.

In planning to do the work on a profitable basis, the men must be trained to specialize in certain operations. For example, the man engaged in welding high-speed

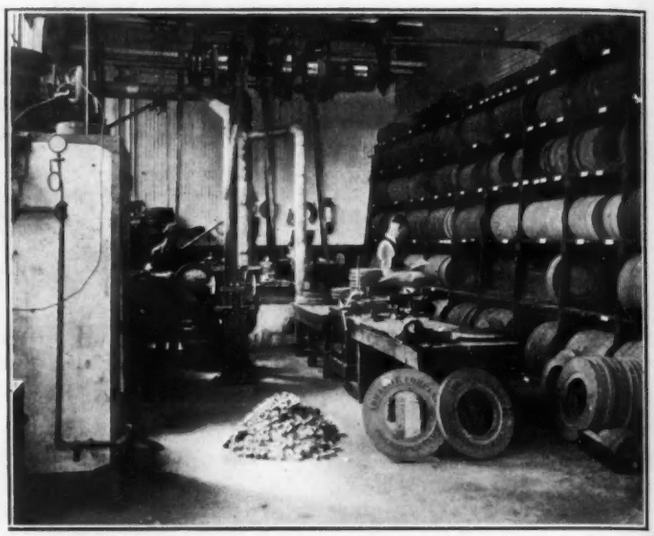


FIG. 6—GRINDING-WHEEL SALVAGE
In This Part of the Salvage Department, Grinding Wheels are Redressed and Conditioned for Use on Their Former or on Other Shop Work

steel tool-bits to carbon-steel shanks or in welding new heads on braces and socket wrenches, as shown in Fig. 3, and who becomes efficient in this work, must not be expected to be equally as efficient in the precision grinding of tools. However, many other jobs exist on which he

DIAMOND NO. BC 258

DIAMOND TOOL RECORD

DIA. NO. BC 258 WT. 1.38 COST $55.00	PURCHASED FROM Barnard Bandler & Sons
KIND Fine Cape Rivers	P.O. NO. DATE 8/30/22
DIAM. 24 WIDTH 3 WIDTH HOLE 5	LOT NO. BC CARAT PRICE $40.00
GRAIN 6824 GRADE CM Norton	COLOR White QUALITY
WT. ISSUED 1.38 WT. RET'D. .17 WT. LOST 1.21	CONDITION WHEN ISSUED O K
TOTAL DRESSINGS 405 DIA. COST PER DRESS.	Purchased 4/18/23
TOTAL SETTINGS 12 SET COST PER DRESS.	CONDITION WHEN RETURNED Fair
DRESS. PER CARAT 424 TOTAL COST PER DRESS. .09	

REMARKS This stone satisfactory for performance

DIAMOND NO. BC 258

DATE SET	DATE ISSUED	CRIB NO.	OPERATION	SIZE OF WHEEL	WEIGHT ISSUED	DATE RETURNED	WEIGHT RETURNED	LOSS-IN WEIGHT	NO. OF DRESSINGS	REMARKS
8-30-22	12-4	11	Gears	14 x 2 x 5	1.38	12-22	1.31	.07	25	24 CM
12-22	12-22	8	Cranks	18 x 3 x 5	1.31	1-5-23	1.23	.08	20	24 CM
1-4-23	1-4	8	" " "	1.23	2-14	1.18	.05	170	"
2-14	2-14	1	Cams	18x 1 1/2x5	1.18	2-23	1.13	.05	47	46-4 Elec
2-26	2-26	1	Cranks	18 x 3 x 5	1.13	3-9	1.05	.08	61	6824 CM
3-10	3-10	1	"	" " "	1.05	3-17	.98	.08	58	"
3-18	3-18	1	"	" " "	.98	3-29	.45	.53	82	"
3-30	3-30	6	Gears	14 x 2 x 5	.45	4-3	.32	.11	20	24 CM
4-3	4-3	6	"	" " "	.32	4-6	.26	.06	20	"
4-7	4-7	6	"	" " "	.26	4-8	.19	.07	12	"
4-10	4-10	6	"	" " "	.19	4-14	.17	.02	20	"
4-18	4-18	6	"	" " "	.17	5-10				
								1.21	405	

FIG. 7—DIAMOND-TOOL RECORD-FORM
Records of the Diamonds Used, Their Performance and Their Value Are Kept in Minute Detail. Salvage-Department Methods Have Reduced the Number of Diamonds Needed

can be employed, such as recasting lead hammers, refacing copper and rawhide hammers, brushing and sandblasting files. The welding equipment used is illustrated in Fig. 4.

In classifying the men employed in tool salvaging we have the blacksmith, the heat-treatment man, the welder, the machinist, the tool-maker, the emery-wheel cutter, the grinder and the all-round bench-man.

Details of Tool-Reclamation

The low scrap-value of worn-out tools stimulates the determination to find ways and means to reclaim all that is possible. The shanks of large quantities of drills are reground, and reamers with broken tangs are reground to provide new tangs. Worn-out drills, reamers, counterbores, milling cutters, saws, end mills, plug and ring gages, arbors and the like are ground to smaller sizes, care being taken in the selection of grinding wheels and in performing the operations so as not to draw the temper of the tool. An effort is made to make the tools as nearly equivalent to new as possible, so as to avoid prejudice on the part of shop men. Tools salvaged in this manner are as good as new in most cases, and the cost of salvaging compared with the cost of new tools shows a saving of 65 to 75 per cent. Specimens of reclaimed milling cutters, drills, reamers and files are shown in Fig. 5.

High-speed-steel tool-bits too short to be properly supported in the tool blocks are welded to carbon-steel shanks. The sides are then ground to fit the tool block, the cutting edge is ground to conform to the blue-print specifications, the tool number is marked on it and it is returned to tool stores. Considering the cost of high-speed steels, this procedure proves very profitable. Small pieces of stellite are also welded to soft-steel, and considerably more than its scrap value is realized in this way.

Fig. 8—Emery-Wheel Cutting
Improvements in Methods Have Resulted in Cost Reductions

Grinding Wheels and Diamond Tools

Grinding wheels sent to be salvaged are usually rebushed and then recut to various diameters, widths and shapes to meet shop requirements. This division of the salvage department is shown in Fig. 6. Obsolete grades are disposed of at attractive figures, whenever possible. The mounting and balancing of all grinding wheels, and the maintaining of lapping heads for production purposes throughout the shop, are part of the duties of this branch of salvage. Table 3 is typical of a weekly salvage-department report on grinding wheels.

It follows as a logical consequence that the selection of diamonds for dressing grinding wheels and the supervision of the diamonds should also be carried on by the same department. A diamond-tool record is shown in

EMERY WHEEL DEPARTMENT

PART NO. 33138 PART NAME Crankshaft MAKE OF WHEEL A
DEPT. NO. 50 OPERATION NO. 300 MACH. NO. B-992
PIECES PER DRESSING 5 STOCK REMOVED .060 DATE 10-6-24
DIA. 24 WIDTH 1.529 HOLE 12 GRAIN 46 GRADE P HOURS RUN 15
DATE WHEEL INSTALLED 10-2-24 DATE WHEEL REMOVED 10-4-24
OPERATION Rh.Gr.Pins MAKE OF MACH. Landis COUNTER SUNK
S.F. 6000 R.P.M. 955 DIAMOND OR DRESSER Place's
RETURN THIS CARD TO TOOL CRIB WITH WHEEL WHEN WORN OUT
Cranks Ground 340 Total number of Pins 680
A Order 359845 Our order 39415

EMERY WHEEL DEPARTMENT

PART NO. 33138 PART NAME Crankshaft MAKE OF WHEEL B
DEPT. NO. 50 OPERATION NO. 300 MACH. NO. 1645
PIECES PER DRESSING 5 STOCK REMOVED .060 DATE 10-7-24
DIA. 24 WIDTH 1.529 HOLE 12 GRAIN 46 GRADE P HOURS RUN 15
DATE WHEEL INSTALLED 10-3-24 DATE WHEEL REMOVED 10-6-24
OPERATION Rh.Gr.Pins MAKE OF MACH. Landis COUNTER SUNK
S.F. 6000 R.P.M. 955 DIAMOND OR DRESSER Place's
RETURN THIS CARD TO TOOL CRIB WITH WHEEL WORN OUT
Cranks Ground 205 Total number of Pins 410
B Order C-47515 Our Order 39730

Fig. 9—Comparative Grinding-Wheel Records
For Wheels *A* and *B*, Note the Difference Shown in the Number of Cranks Ground Under Similar Conditions

Fig. 10—Diamond Setting
Tools Used for Redressing Grinding Wheels Are Diamond Pointed. Great Care and Skill Are Needed in Setting the Diamonds Properly

TABLE 3—WEEKLY SALVAGE DEPARTMENT REPORT

The following Grinding Wheels have been supplied to Central Stores on Purchase Requisitions for the Week Ending Aug. 15

Quantity	Description	Requisition Number	Total Price
4	28 x 1¾ x 12 24-C. N. Norton Alundum (Cut to 26 x 1.404)	2,102	$97.00
4	22 x 2½ x12 24-C. M. Norton Alundum (Cut to 2 27/32 in.)	2,143	80.00
10	16 x 1½ x 1¾ 20-R Abrasive Borlon (Rebushed)	2,153	69.30
4	24 x 4 x 5 24-60 Norton Alundum (Dished on One Side)	2,155	145.00
6	18 x 1¼ x 8 33¼ Waltham Elastic (Cut to 12-in. hole)	2,160	96.60
1,000	3 x ¾ x ¾ No. 180-G-6 Carbon Lapping Stone (Reworked)	2,170	300.00
[redacted]			Total $787.90

Fig. 7. The principal result of this arrangement was the substitution of other equally effective equipment, shown in Fig. 8, for dressing the emery wheels that are used on the various jobs. Comparative grinding-wheel records are shown in Fig. 9. An immediate reduction in the quantity of diamonds used was evident, and also a very substantial saving in cost per dressing. For example, on one particular job the cost per dressing with a diamond was 0.052 cents but, by using a dressing tool, this cost was reduced to 0.004 cents per dressing. The actual total saving effected in diamond costs for a period of 1 year amounted to $18,817.39. Fig. 10 illustrates the operation of setting diamonds used for dressing grinding-wheels.

Much valuable information regarding the uniformity of grades, durability, general performance and finish produced by the different makes of wheel tried out is compiled and available for reference in our salvage reports to those who are interested further in this subject. The salvage department is not organized to attempt to set a basis for an accurate percentage of new-tool expense saved by the use of reclaimed tools. Its ultimate purpose should be its functioning with the least possible friction and the rendering of the most effective service to all other departments.

GUSTAV E. FRANQUIST

ONE of the pioneers of the automotive industry in America and a Founder Member of the Society, Gustav E. Franquist, passed away in the Presbyterian Hospital, Philadelphia, on Sept. 15, 1924, following a brief illness, at the age of 50 years. He is survived by his wife and a brother.

Mr. Franquist was born at Ishpeming, Mich., May 19, 1874. His early youth was spent in Chicago. In 1900, at a time when the "horseless carriage" was a rare sight and an object of curiosity, he entered the service of the Buffalo Spring & Gear Co., which was then starting to build a carriage that was propelled by a one-cylinder two-cycle engine. In 1902 Mr. Franquist became the superintendent and engineer for Smith & Mabley, which company was engaged in importing and selling Mercedes and Panhard automobiles. About that time this company decided to produce a car of its own and, in 1903, the design of the first automobile was conceived by Mr. Franquist and its building undertaken. The first cars were called the Smith & Mabley Simplex; later, the name was changed to Simplex.

The possibilities of the gasoline-driven motorboat became apparent about this time and the Simplex Co., in 1903, built the first real speed-boat ever seen in this Country. It was the famous Vingt-Et-Un, so-called because it was capable of a sustained speed of 21 m.p.h. This boat was followed by the Challenger, which went to England to compete for the newly offered Harmsworth cup; but it was not successful. The Dixie I, which followed the first challenger, was successful, and brought the cup to America. These boats were built, hulls as well as engines, by the Smith & Mabley interests. The hulls were designed by Clinton H. Crane, of Tams, LeMoine & Crane, Mr. Franquist designing the engines and supervising the construction of both the hulls and the engines.

Mr. Franquist contributed much to the industry in its infancy. He was one of the small group of pioneer American automobile engineers. When the Wright-Martin Company acquired the Simplex business in 1915, Mr. Franquist resigned and went to Cuba to devote his time to his interests there. When the United States entered the World War he returned and, from 1918 until the end of 1923, he was chief engineer of the James Cunningham & Sons Co., Rochester, N. Y.

FRANKLIN HALL MARMON

WHILE returning from a car-test trip from Indianapolis to Denver, Franklin Hall Marmon, son of Walter Marmon, chairman of the board of the Nordyke & Marmon Co., was killed in an automobile accident. Near Indianapolis, the car skidded in soft gravel as it turned out to pass another automobile. He was 25 years of age, and is survived by his wife and an infant daughter.

Mr. Marmon was born June 4, 1899, at Indianapolis, and was educated in the elementary schools of that city and in the Manual Training High School there in preparation for his technical course at the Massachusetts Institute of Technology. Since his graduation, he had been connected with the Nordyke & Marmon Co. and was in charge of its experimental work at the time of his deplorable death. His other automotive activities were centered in the Indiana Section of the Society, as chairman of its Meetings and Papers Committee. He was elected to Junior Member grade in the Society, June 21, 1917.

Durability of Plated Surfaces

By W. M. PHILLIPS[1]

PRODUCTION MEETING PAPER *Illustrated with* PHOTOGRAPHS

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

SUITABLE physical characteristics of the plate and a thoroughly clean metal surface upon which to deposit it are essential if an adequate thickness of plating is to be attained to make it durable. It pays to provide a good metal surface to receive the plate.

Adequate cleansing of the surface to be plated cannot be overemphasized. This can be accomplished by using, in all preliminary operations, only greases that can be removed easily, by using suitable equipment and the proper type of cleaning compound, and by dipping in a pickling solution of hydrochloric acid and water.

All the abrasive-wheel operations before the actual plating is done are included in the term "polishing" and, since it requires skilled workmen, plating can be done more economically if this item of cost can be lessened. When the cost is fixed, it often is best to spend less on the polishing and more on the plating.

Steel plated with nickel is considered next, tests having shown that the average thickness of nickel-plating on a certain car was only 0.0001 to 0.0002 in., or less than one-tenth the thickness of tissue paper. Since the other protective coatings, the paint and the enamel, vary in thickness from 0.002 to 0.004 in., arguments are presented in favor of making the nickel-plating thicker.

Some details of plating are discussed and illustrations of plating and testing equipment are presented.

The cost of the usual grade of nickel-plate is compared with that of the so-called heavy plate, to the advantage of the latter, and the necessity for using laboratory methods throughout the process is emphasized. In conclusion, five of the main ideas expressed in the paper are specified briefly.

[1] General Motors Corporation, Detroit, Mich.

FIG. 1—THE POLISHING-ROOM AT THE OLDS MOTOR WORKS
All the Polishing-Lathes Are Motor-Driven and the Room Is Well Lighted, It Being Particularly Important that the Men See Their Work and So Be Enabled To Do It Effectively. Note the Location of the Plating-Tanks with Respect to that of the Polishing-Machines

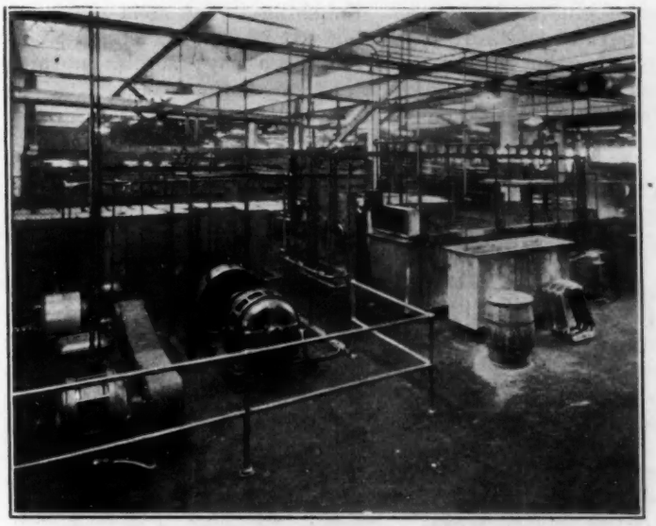


FIG. 2—THE PLATING-ROOM AND CONVEYOR PLATING-TANKS
These Cathode Tanks Are Equipped with Conveyors and Are Used for Copper-Plating. The Parts To Be Plated Are Suspended Inside the Tank at the Near End, Conveyed Along Through the Plating Solution and Removed from the Far End, Thus Lessening the Amount of Walking Needed To Load and Unload the Tanks

NICKELED radiator-shells and other steel parts of automobiles are very much the style at present. It is obvious that the nickeled-plating should be made very durable, this being particularly necessary in connection with the use of the better grades of automobile finish, such as those of the nitro cellulose or lacquer type.

Thickness of plate has proved to be an essential factor if the plating is to be durable, but to secure a plating of the desired thickness that will adhere to the metal satisfactorily requires that the plate itself have suitable physical characteristics and that the surface to which it is applied be clean. Further, the metal to which plating is applied should be as free as possible from blemishes and pits, this being especially important when plating steel or iron. There should be no slag or anything else on the surface; only the metal itself. It pays to provide a good metal surface on which to deposit the plate.

CLEANSING THE WORK

Before being plated, the parts must be cleaned thoroughly. Grease, rust and scale must be removed completely. The importance of adequate cleansing cannot be overemphasized. One method is to use, in all the preceding operations, greases that can be removed easily. Another is to provide suitable equipment and the proper type of cleaning compound for the work to be done.

It is customary to dip the parts into a "pickling" solu-

tion, which is composed of hydrochloric acid and water. This removes all rust and traces of alkali that may exist on the surface to be plated. The solution can be used either with or without the aid of electric current.

Polishing

All the abrasive-wheel operations before the actual plating is done are included under the term "polishing." Most of this work is done on wheels made of muslin, felt or leather, the ground abrasive being held on the wheel by glue or by grease. Polishing is the most expensive part of the work of plating. It is done by skilled workmen who receive relatively high pay; so, if anything can be done to reduce this item of the cost, plating can be done more economically.

Fig. 3—Conveyor Tanks for Nickel-Plating
The Nickel-Plating of All the Car Parts So Treated Is Done in these Cathode Tanks. A Great Advantage of the Conveyor Tank Is Its Passage of the Parts Through All the Plating Solution and Consequent Production of Plating that Is Uniform

In plating steel parts, it has been the practice in some instances to make a very thorough job of the polishing. The resultant product then had a very pleasing effect just after it was finished. But, if too much of the available money is spent on the polishing, less can be spent on the plating and it will not have as great durability. When the cost is fixed, it often is best to spend less on the polishing and more on the actual plating.

Plating

Let us consider the plating of steel with nickel. Recently, tests were made to determine the thickness of the nickel-plate on the parts of a popular-priced car. On some of the parts the plating was extremely thin; the average thickness being between 0.0001 and 0.0002 in. The thickness of a piece of tissue paper is about 0.002 in. and hence the foregoing average thickness of plate was less than one-tenth the thickness of tissue paper. The other protective coatings on the car, such as the paint and the enamel, vary in thickness from 0.002 to

[2] See The Journal, February, 1924, p. 127.

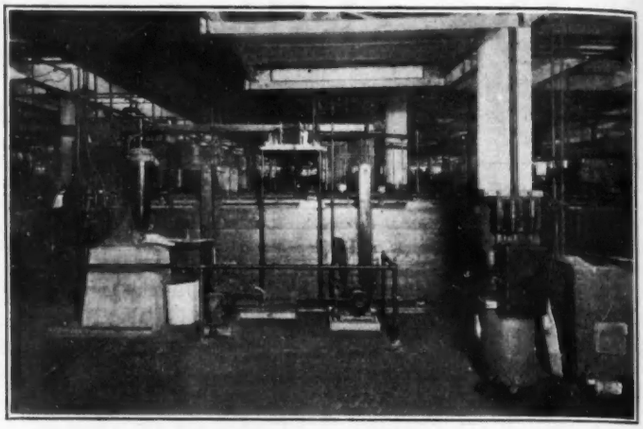


Fig. 4—Plating Equipment, Electric Generator and Filtering Apparatus
Electric Current at the Proper Voltage for Plating Is Furnished by the Generator. By Means of the Filtering Apparatus Shown the Plating Solution Is Kept Clean

0.004 in.; that is, they are from 10 to 20 times as thick as the plating mentioned.

If the surface of the work be reasonably well polished, it can be plated lightly with a preliminary coat of nickel, say 0.0001 in. thick. This is recommended by Edwin M. Baker in his paper on the Rust Resistance of Nickel-Plated Steel.[2] One advantage of this procedure is that, because nickel has more "throwing" ability than has copper, it is more likely to plate into the crevices and deep portions of the work than is true in the case of copper.

Whether a preliminary plating with nickel is made or not, the part being plated should receive a good heavy deposit of copper, plated-on in a manner that will assure

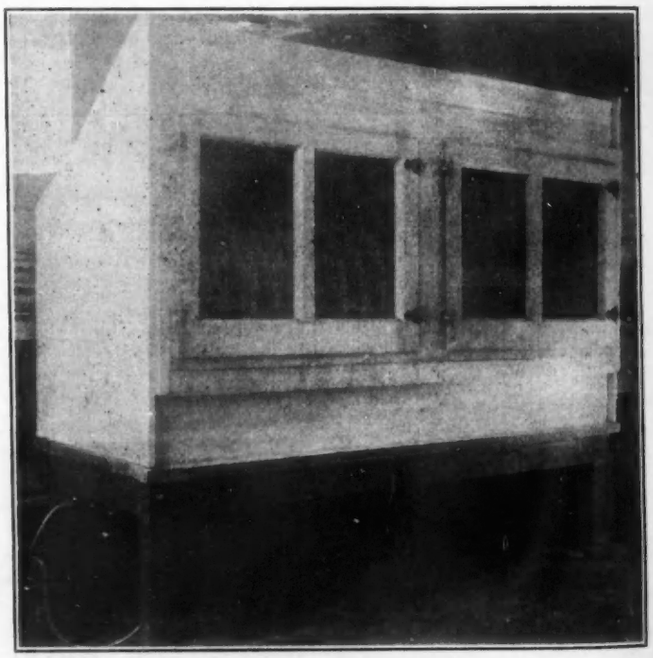


Fig. 5—Salt-Spray Testing Apparatus
This Type of Test Equipment Is Used at the Plant of the Jaxon Steel Products Co. It Is Located in the Chemical Laboratory, in which the Raw Material Is Analyzed, the Plating Solutions are Prepared and the Finished Product Is Tested. Zinc-Plated Rims Are Tested at Least 48 Hr., but This Specification Is More Severe Than Is Deemed Advisable for Nickel-Plate at Present. This Type of Equipment Is Needed where Large Quantities of Parts Are To Be Tested

good physical characteristics. If the preliminary nickel-plating has been applied, an acid-copper bath can be used for this purpose; if no first plating with nickel has been made, a cyanide-copper bath must be used.

The copper plate should be 0.0003 in. thick, or more, the idea being that, because copper is softer than steel, it is easier and therefore cheaper to produce a good surface in this manner than it is to polish the steel to a fine surface during the preliminary operations.

By depositing a good heavy copper-plate, it often is possible to eliminate one or more of the polishing operations. The subsequent buffing should be done very thoroughly. This will cost a little more than to polish a very light deposit of copper; however, it will cost less than any one of the polishing operations on steel. This buffing tends to cover scratches and pores in the metal surface, and will leave it comparatively smooth. The work should then be cleaned thoroughly and the final nickeling operation concluded. The thickness of the final nickel-plate should be at least 0.0002 in.

Fig. 1 shows the polishing-room at the Olds Motor Works, and the relation between the locations of the plating-tanks and the polishing-machines. All the polishing-lathes are motor-driven; and the room is well lighted because it is essential that the men who do the polishing see their work clearly and thus be enabled to do the polishing effectively.

Fig. 2 illustrates the cathode plating-tanks used for copper-plating; they are equipped with conveyors, inside. The parts to be plated are suspended within the tank at the near end, conveyed along through the plating solution and then removed from the far end, thus lessening the amount of walking needed to load and unload the tanks.

Fig. 3 is a view of the cathode conveyor-tanks used for the nickel-plating of all the car parts so treated. A great advantage of the conveyor-tank is its passage of the parts through all the plating solution and consequent production of plating that is uniform.

In the view of the plating equipment reproduced in Fig. 4, the generator shown furnishes electric current at the proper voltage for plating, and the filtering apparatus affords a means of keeping the plating solution clean.

Cost

Considering a steel radiator-shell, for example, the cost of each polishing operation may average 9 cents. If seven polishing-wheels are used, the polishing will cost 63 cents. The plate will be about 0.0002 in. thick and will cost about 6 cents. The most of these costs is for labor. Two buffing operations at about 9 cents each will cost 18 cents; making the total cost about 87 cents.

If the heavy-plate method is used, two polishing operations can be eliminated; and, if five polishing wheels are used at 9 cents for each, the cost will be 45 cents. A heavy plate requires that the work remain in the plating-tank longer and means that more metal will be deposited, but the amount of labor required remains the same. Suppose the heavy plate costs 12 cents more than does the plate for the former method, and that the buffing costs 2 cents more; the finished-product cost will be about 2 cents less than with the usual method, but the plate will be three times as thick.

Testing

Thickness of plate can be determined by chemical analysis. A piece of paper or other suitable material, 1 in. square, is placed on the finished surface and brushed over with paraffin; the paper square is then cut out with a sharp knife and removed, the plating under it is dissolved with nitric acid and the amount of plate metal determined by usual methods.

Salt-spray tests should be made also, in accordance with the method recommended by the Bureau of Standards; or a suitable modification of this method should be made and used.

Fig. 5 shows the type of salt-spray testing-apparatus used at the plant of the Jaxon Steel Products Co. It is located in the chemical laboratory there, in which the raw material is analyzed, the plating solutions are prepared and the finished product is tested. Uniform results from plating cannot be expected unless the determinations are made in a laboratory, for, it must be remembered, the work of plating is done to limits of the order of 0.0001 in. One would not expect a tool-maker to work to such fine limits unless he were equipped with suitable micrometers and gages; and the need for chemical tests in plating work is fully as great.

Zinc-plated rims and rim parts are tested for at least 48 hr. in the salt-spray apparatus shown in Fig. 5. But this specification is several times as severe as is deemed safe for nickel-plated articles at present. This type of equipment is needed when it is necessary to test large quantities of parts.

Summary

In conclusion, let me state again the main ideas I have tried to convey. They are summarized by saying that

(1) Polishing costs constitute the largest item in nickel-plating; they are too high

(2) Plating is the most important part of the process. The average thickness of nickel-plate is but one-tenth the thickness of tissue paper; by making the plate thicker the polishing cost can be made enough less to compensate for the additional cost of the thicker plate

(3) Thick plate that has good physical characteristics probably will be durable

(4) The chemist and the plater should cooperate.

(5) Nickel-plate should not be considered satisfactory because it looks all right; it should be tested to make certain that it is all right

The Group Wage-Payment Plan

By H. G. PERKINS[1]

PRODUCTION MEETING PAPER

[C 54 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings]

ABSTRACT

METHODS of wage payment that increase the incentive of employes produce more desirable results than the flat-rate or the day-rate method, the latter being unsatisfactory because it limits the earnings of an ambitious workman and does not assure the employer of a definite return for a definite wage paid. Piece-work is a development that bases remuneration on effort; in all methods of incentive wage-payment, the employe's effort is a measure of the pay check. Accuracy in the methods employed in pay-roll protection demands voluminous detail and is in direct proportion to the expense involved in maintaining the methods.

When faced with the alternative of increasing the expense of pay-roll protection or of discarding the system then in use, the Maxwell Motor Corporation decided to investigate the group wage-payment plan previously adopted by the General Motors Corporation. After it had been installed in two departments, this system was found to be very successful in one department but a failure in the other. This called attention to the fact that certain fundamental requirements are essential to success. These requirements are enumerated by the author, as are also the principles that ensure the best distribution of earnings among the members of a group. Adherence to these requirements and principles is said to have produced so spectacular results that the method has been made standard in all departments that are adaptable to group work.

Among the outstanding results of the system are great increase in productive efficiency, because the wages increase with the production; great interest among the men, because the spirit of teamwork is capitalized; labor costs have been lowered, because of the increased productivity; the standard of quality has been improved; the accuracy of production has increased with a decrease in the expense; fraudulent practices and overpayment have been overcome; the volume of scrap has been reduced, because the group receives credit only for the pieces finished and approved by an inspector and the number of rejections is diminished; the desirability of employment has been increased, consequently the labor turnover has been reduced; new men are broken in by the old ones more quickly, in order that the performance standard of the group may be maintained; productivity has been increased with less manpower; supervisors are kept more closely in touch with the performance of the various manufacturing units; efficiency figures show the comparative performance of each group in comparison with the standard performance established by the time-study department; and the weekly reports give, in addition to the efficiency figures, the day rate of pay, the actual earned rate, the number of men in the group, and the amount of the allowances. These reports enable the executive to get a very definite picture of the whole organization in a few moments.

IT is generally agreed that methods of wage-payment that increase incentive produce more desirable results for both the employer and the employe than does the flat-rate or the day-rate method. From the standpoint of labor, the day-rate basis provides a definite and set wage per day or per hour but is unsatisfactory because an ambitious workman is limited in his daily earnings regardless of the effort expended. From the employer's standpoint, the day-rate agreement with labor is unsatisfactory because, for a definite wage paid, the returns from the workman are not definite. All employes are therefore quickly reduced to the level of the least efficient and the least desirable.

General dissatisfaction with the earlier methods of wage-payment resulted in the development of new methods that based remuneration on effort. The most common of these is the piece-work method. This is a very general term, having a widely different application of detail in different organizations. All methods of incentive wage-payment, however, have one thing in common: a measure of the employe's effort must be secured as the basis for the pay-check. Some factories have installed an ingenious and thorough routine for this purpose; others have very slipshod schemes. At best the accuracy that is essential, if the payroll is to be properly protected, requires voluminous detail. Of the individual piece-work plan it may be said that the accuracy of the methods employed is in direct proportion to the expense involved in the maintenance of the methods.

Two years ago our management was faced with the problem of pay-roll protection. It was necessary either to increase the expense of the operation of the system then in use, or to discard the system in favor of one that would produce the desired results without an increase in expense. Investigation of the General Motors group-method, which was the subject of a paper[2] read to the Society by E. K. Wennerlund, its originator, gave promise of being the solution of this problem.

After a thorough study of the principles of this method and a careful adaptation of these principles to our conditions, we attempted an experimental installation in the differential-case department. Simultaneously, another group-method, having the piece-work principle as its basis, was tried in the crankshaft department. Excellent results, which will be enumerated later, were secured in the differential-case department, but in the crankshaft department the methods employed were so unsuccessful that they had to be speedily withdrawn.

FUNDAMENTAL REQUIREMENTS FOR THE SUCCESS OF THE SYSTEM

From our experience with these departments we discovered that a strict observance of certain fundamentals is absolutely necessary to assure success. These basic principles are:

(1) Individuals can be grouped successfully only when they have a community interest in the result of their combined efforts
(2) Individual interest in individual accomplishment must be retained, the success of the group being based on individual incentive and ambition
(3) The group must receive *all* the directly increased wages accruing from increased production
(4) The plan used must be sufficiently simple to be understood by the workmen
(5) There must be confidence in the management, induced by the square deal

[1] Industrial Engineer, Maxwell Motor Sales Corporation, Detroit, Mich.

[2] See THE JOURNAL, Jan. 1923, p. 27.

(6) The supervisory and operating personnel must believe in the group idea

(7) The system should be installed by thoroughly competent specialists, who are familiar with the functions of the time, cost, inspection, planning, and shop departments

(8) There must be a just distribution of group earnings to the individuals of the group

The last-named of these principles requires routine that is sufficiently flexible to operate successfully when recognition is given to the following variables:

(1) Different degrees of skill and ability are required on different operations within the group

(2) Different degrees of skill and ability will be found in different workmen engaged on the same or parallel operations within the group

(3) Veteran employes are entitled to more consideration than are newcomers

Adherence to these principles produced so spectacular results in the differential-case department that it was decided to make the method standard throughout all departments of the various plants that were adaptable to group work. All phases of automobile manufacturing are represented in our organization at one plant or another, and in very few cases have we found difficulty in installing group principles. Not only have we been successful in single-purpose departments producing one definite product continuously, but we have secured equally satisfactory results in such departments as the wood mill, automatics, heat-treating, and enameling. In fact, the departments having a varied product were the most fertile fields for eliminating the expense and increasing the accuracy of production.

The details of the operation of our group-payment plan are so similar in principle to those outlined by Mr. Wennerlund that I shall pass over them, and discuss some of the outstanding results observed from their actual operation for a period of more than 2 years. No attempt has been made to list these observations in the order of their importance, except that in a general way a few of the more important ones will be mentioned first.

Some Outstanding Results

The most outstanding and most significant result has been a spectacular increase in productive efficiency, which means more production per man-hour and per machine-hour.

Several contributing causes have aided in producing this result, which in general may be said to be due to adherence to the basic principles previously mentioned. In the first place, the workmen have received all the direct benefit of the increased production, because our methods provide for a direct increase in wages proportionate to the increase in production. There is confidence in the management, because the standards determined by the time-study department are definitely guaranteed for a definite period, during which the workmen are assured that no cuts will be made, regardless of the amount earned. These conditions remove the restraint to effort that is present when the workmen have apprehensions that high earnings will result in a cut in the standards.

The psychological effect of the spirit of teamwork is capitalized in group work, since it instinctively spurs the individual to increased effort. The wider range of interest offers a wider field for the application of idle time, which on an individual basis would be lost. Choke-point operations receive group aid when necessary, and machine or tool difficulties are more quickly removed. Physical evidence of "system" in the shop is entirely absent and the routine makes no demand on the workman's time, to divert him from continuously performing his assigned operation.

The results obtained from increased productivity, which has ranged from 12 to 35 per cent, cannot be overestimated. The effect on the burden-rate can be readily appreciated, since the increase in production is secured without a corresponding increase in expense. So many time-saving possibilities are presented by the introduction of group work, for which the management is entitled to credit, that no difficulty has been experienced with the workmen in revising the standards when efficiencies have been found to be abnormally high at the expiration of the guarantee period. By this means, we have reduced the direct labor-costs very materially. Curiously, the groups respond to the new standards and quickly reestablish a very satisfactory efficiency rating, closely approximating their original performance.

In general, then, both the company and the employes have benefited greatly. Saving in direct labor-costs, amounting to several hundred thousand dollars annually, has gone hand in hand with the greatly increased size of the pay envelopes. Some indication of the attitude of our employes toward the new plan may be gathered from the fact that shortly after its introduction we were besieged with requests for its installation from both foremen and workmen.

Reduction of Labor-Cost an After-Effect

The group-payment plan was not installed primarily to reduce direct labor-costs, however. In fact, this result was an after-effect. Our principal purposes were to maintain a high standard of quality, to protect the payroll by securing greater accuracy in production counts, and to eliminate the expense of securing and tabulating these counts.

Periodic investigation of our individual piece-work wage-method frequently brought to light unquestionable evidence of overpayment, and fraudulent practices were not entirely absent. These faults have been overcome by the group method, which provides for payment to the group on the basis of a count taken but once, by the inspector who accepts the finished product.

Greater accuracy has been secured at an actual decrease of expense, because of the elimination of clerical detail. At the Chrysler plant, for example, 65 per cent of the productive labor is now operating on the group basis; and we have already removed nine employes from the shop time-keeping force.

The group-payment plan has had a direct influence on the volume of scrap. Under the individual piece-work method, placing of responsibility for scrap was difficult, and it was common practice to pay for pieces finished rather than for pieces accepted by inspection. Since the group is held jointly responsible for defective work it is unnecessary to penalize the individual, for the group receives credit only for the finished pieces accepted by the inspector. This practice not only obviates the possibility of paying for rejected parts, but also materially reduces the volume of rejections, and assures the quality of the product. And since the inspector is required to provide pay-roll credits, he has been placed in closer contact with production, with the result that the quantity of finished material awaiting inspection has been greatly decreased. Defective workmanship is therefore detected more quickly, and corrective measures may be taken before a great amount of scrap has been made.

Influence on Employment Situation

The group-payment plan has had a marked influence on our working force and the employment situation in various ways. The increase in the pay-check has made our shops more desirable places in which to be employed, and has had a decided effect on the labor turnover, which has been appreciably reduced. Also, since this method provides for higher day-rates than were used with the piece-work plan, there exists a very impressive lure to the better class of workmen, to attract him to our gates for employment.

Then, there is the very important matter of the handling of new men. When injected into a group, they are a handicap until they become experienced in the work. Hence, the older and more experienced members of the group lose no time in advising and educating new members, thereby bringing them more quickly to the performance-standard maintained by the group as a whole. Somewhat parallel to this is the very important effect of group-work on incompetent and indolent workmen. They receive little toleration from the group, and either mend their ways or are quickly eliminated.

The most important consideration, however, is the increase in productivity, which makes the manpower requirement considerably less for a given schedule. The efficiency rating of a group may be increased in either of two ways: increasing the production with the same number of men, or maintaining the same production with a smaller number of men. Since we do not allow production in excess of the schedule, many groups found their efficiency to be limited by their manpower. This had the almost universal effect of eliminating some of the manpower, while maintaining the scheduled production. No direct benefit is enjoyed by the company because of the reduction in working force, since the same amount of wages is paid to a smaller number of men, but the men released from a group become available for use in other departments where a labor shortage may exist. The effect of this conservation of manpower, through increased efficiency, is of enormous significance, not only to the employes and the employer, but to the community. Contemplation of a Nation-wide increase in productive efficiency presents a picture having many interesting aspects and great economic importance.

Executives Kept Better Informed

Too much emphasis cannot be placed upon the fact that our shop supervisors and manufacturing executives are now better informed as to the actual performance of the various manufacturing units than was possible under the individual piece-work plan. Performance reports, issued daily and summarized weekly, carry very significant and very valuable information.

The key to these reports is an efficiency figure representing the comparative performance of each group in relation of the standard performance established by the time-study department. This figure is a very definite and concrete thing, much more significant than a rate of pay per hour, which is merely relative. A group operating at 75-per cent efficiency is doing only three-quarters of the amount of work required to equal our standard performance, and a group operating at 150-per cent efficiency is exceeding the standard by one-half. A very low or a very high efficiency indicates the presence of conditions that should be immediately investigated.

Supplementary to the efficiency figure, the weekly report carries the day rate of pay, the actual earned rate, the number of men in the group, and the amount of allowances, if any, that have been granted by the foreman to compensate for the presence of irregular conditions and unusual manufacturing difficulties. The busy executive, after a few moments' study of these reports, is able to secure a very definite picture of the performance of his whole organization.

The group-payment plan has been a tonic to our manufacturing organization because of the elimination of wasted time and effort, the simplification of routine, and the introduction of a tantalizing, ever-climbing goal to the workmen.

INSPECTION METHODS SYMPOSIUM

(*Concluded from p.* 439)

MR. JONES:—They are covered in the inspection at the Highland Park plant.

QUESTION:—Then your laboratory works directly for the inspection rather than for the engineering department?

MR. JONES:—Yes.

R. EMERSON:—In aircraft construction we have the slogan, "Your error may cost a good man's life." That shows the extreme importance of rigorous inspection. I think we still have much to learn in the automotive field.

MR. FRAUENTHAL:—I meet a great many vendors. Very often, when I complain about something, they throw their hands in the air and say, "We have been giving those to Cadillac and Pierce-Arrow for years. You are the only one that 'kicks' about them." I think the chief inspectors of the various plants should get together. There is no reason why we should not mention a few names to one another and become familiar with the fruits of the vendors' representatives. The inspectors should get together and tell one another what tolerances they are trying to hold to and why. The vendor may get a complaint from one plant and pay but little attention to it; if he gets the same complaint from half a dozen others it will impress him. One small plant "bucking" a big vendor cannot do much good.

CHAIRMAN HERRMANN:—R. H. Nickerson[1] has made some interesting experiments showing the life of plug gages under certain tolerances. He has found that the material of which the gage is made has an enormous influence. He also found that finish is a very important factor, much more than he expected when he began his experiments. He ran a series of lapped gages of different degrees of fineness until he finally got what was required to give the maximum life. At the present time all incoming gages are inspected under the microscope for surface finish. This has more than paid for itself in the accuracy of the work and in the life of the gages.

[1] Supervisor of inspection, Studebaker Corporation of America, South Bend, Ind.

MEETINGS OF THE SOCIETY

(*Concluded from p. 392*)

would withstand the salt-spray test would last for 4 or 5 min. in the acid. A coating that will last for 1 min. is a good coating. A coating that seemed unsatisfactory, when tested with acid, lasted 15 or 20 sec. This was afterward improved until it lasted 1 min. 35 sec. A quick test can be made by this method and the result verified later by the salt-spray, if desired. The acid will begin to boil as soon as it strikes the base metal; it can then be blown off and the metal exposed. The test applies equally well to brass, iron or steel.

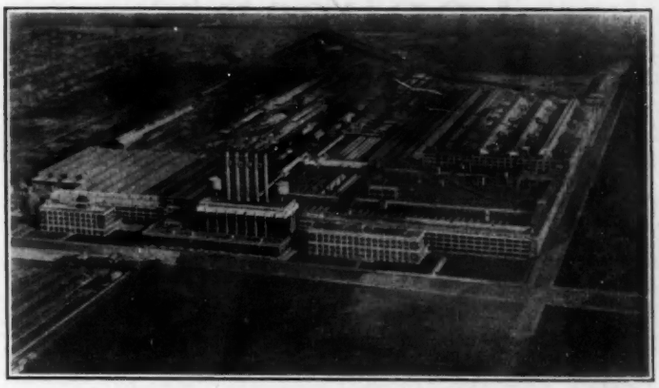
The use of phosphoric or other acids to form an insoluble salt in the pores of the plated surface to prevent rusting, was suggested, but no information was forthcoming.

John McGeorge, of the Oakland Motor Car Co., questioned the ability of polishing to fill up low spots. If this was done, he said, the action was one of burnishing, not of polishing.

In closing, F. J. Taylor, of A. P. Manning & Co., suggested that the question of dip tests and the like had been thoroughly worked out by chemists in connection with the nickel-plating specifications of plumbing supplies. Covering nickel with rouge and with lime differs in that the rouge performs a burnishing operation, whereas the lime colors by abrasion and deoxidization.

THE FACTORY VISITS

Many attendants at the Production Meeting took advantage of the opportunity offered in the factory visitation program. Groups were taken through the Hudson plant on Wednesday and Thursday and on Friday afternoon many more were shown through the Highland Park Plant of the Ford Motor Co., and the factories of Dodge Bros. and the Continental Motors Corporation. The finest type of hospitality was shown the visitors by each of these organizations and the men who made the visits commented favorably on the willingness of the production staff at each plant to dispense production information of the most valuable character. To F. H. Low, V. P. Rumely and G. W. Blackinton, the Society records its appreciation of the courtesies shown the visiting members. Also to C. H. Brennan who handled the transportation of the members to the different factories with dispatch.



THE WORLD'S LARGEST AUTOMOBILE PLANT

This Gigantic Productive Unit of the Ford Motor Co. at Highland Park Was Visited by a Group of Those in Attendance at the Production Meeting in Detroit

OCTOBER COUNCIL MEETING

THE meeting of the Council held in Detroit on Oct. 24 was attended by President Crane, Vice-President Johnston, Second Vice-Presidents Pope and Strickland and Councilors Brumbaugh, Hunt and Rumney; and by H. L. Horning, T. J. Litle, Jr., and H. D. Church, nominees for the 1925 Council.

Plans for coming meetings of the Society were discussed.

Eighty-eight applications for individual membership were approved. The following transfers in grade of membership were made:

From Junior to Member, Fred A. Hoyt, W. H. Yount, Paul L. Gossett, Abbot A. Lane, Ethel H. Bailey, Edmund J. Butler, Val Cronstedt, Donald R. Husted, Carl E. Johnson, Clarence Roy Spooner, Edgar D. Vancil and Harry Williams; Junior to Associate, Harold T. Moore, Thomas M. Hill, G. Rollo Petrie, Arthur I. Schell, Jerome J. Sloyan, Maurice A. Thorne, J. Russell Walsh, Norton L. Dods and Edward W. Kelley; Associate to Member, Ralph B. Burton, Harry F. Bryan, Edwin Frankland, Edward A. Oehler, Francis J. Scarr, Russell H. Stalnaker and Edwin C. Wood; Associate to Junior, Sidney G. Harris; Junior to Service Member, Robert Insley; Member to Service Member, David MacI. Dunwoodie.

It was reported that on Oct. 21 there were 5625 names on the rolls of the Society, including Affiliate Member Representatives and Enrolled Students.

The resignations of 14 members were accepted, and 364 members were dropped for non-payment of dues.

L. P. Kalb was appointed to membership on the Engine and the Electrical Equipment Divisions.

The following subject was assigned to the Engine Division: Engine Front-Trunnions.

Earle Buckingham was named as a representative of the Society on the Sectional Committee on Gears.

President Crane, W. C. Fischer and F. J. Bickelhaupt were appointed to represent the Society at the National Conference on Utilization of Forest Products to be held in the City of Washington this month.

Preliminary appropriations to the Sections of the Society, for the current fiscal year, were made amounting to $4,850.

The Council expressed its approval of the amendments to the Constitution of the Society proposed at Spring Lake, N. J., last June.

The next meeting of the Council will be held late this month or early in December.

DAY AND NIGHT

ALMOST all our present sources of light are hot bodies, 95 per cent of whose radiation is invisible. To light a lamp as a source of illumination is about as wasteful of energy as to burn down one's house to roast one's pork. It is a fairly safe prophecy that in 50 years light will cost 1/50 part of its present price, and night in our cities will be no more. The alternation of day and night is a check on the freedom of human activity which eventually must go the way of every other spatial and temporal check.—J. B. S. Haldane.

Applicants *Qualified*

The following applicants have qualified for admission to the Society between Sept. 10 and Oct. 10, 1924. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff) Affiliate; (S M) Service Member; (F M) Foreign Member; (E S) Enrolled Student.

ANDERSON, IVAN (A) mechanical aeronautical engineer, 583 Fifth Avenue, *Long Island City, N. Y.*

BENDER, BERLIN (A) aviation engine mechanic, Bureau of Standards, *City of Washington*, (mail) 1835 Monroe Street, Northwest.

BLANCHARD, ARTHUR H. (M) professor of highway engineering University of Michigan, 1026 East Engineering Building, *Ann Arbor, Mich.*

BYCE, LISLE D. (M) general superintendent of works, Ottawa Car Mfg. Co., Ltd., *Ottawa, Ont., Canada*, (mail) 21 Willard Avenue.

CHAMPION, E. M. (M) Detroit plant manager, American Motor Body Corporation, Philadelphia, (mail) 12262 Kercheval Avenue, *Detroit.*

CREAMER, CHARLES D. (A) instructor, Michigan State Automobile School, 3729 Woodward Avenue, *Detroit.*

CUNNINGHAM, JOHN HUNTER (F M) chief engineer and designer, W. H. Dorman & Co., Ltd., *Stafford, England*, (mail) 197 Oxford Gardens.

DAVIS, M. MOSS (J) Missouri State Highway Commission, Jefferson City, Mo., (mail) 701 Wall Street, *Joplin, Mo.*

EISINGER, JOHN O. (J) assistant mechanical engineer, Bureau of Standards, *City of Washington*, (mail) 3503 Wisconsin Avenue.

EMERY, JAMES ALBERT (M) vice-president, Ford, Bacon & Davis, Inc., 115 Broadway, *New York City.*

HARMER, F. E. (A) automobile consulting engineer, Raydale, *Chatburn, Lanes, England.*

HENNECKE, EARLE V. (A) vice-president and general manager, Moto-Meter Co., Inc., 11 Wilbur Avenue, *Long Island City, N. Y.*

HUXLEY, T. C., JR. (A) manager of New York branch, Diamond T Motor Car Co., Chicago, (mail) 81 William Street, *Long Island City, N. Y.*

JACK, DANIEL (A) superintendent and service manager, duPont Motors, Inc., Moores, Pa., (mail) 316 Morton Avenue, *Ridley Park, Pa.*

JOHNSON, FORREST L. (J) student, Tri-State College, Angola, Ind., (mail) 638 South Main Street, *Adrian, Mich.*

KELLY, DANIEL H. (A) vice-president, U. S. Light & Heat Corporation, *Niagara Falls, N. Y.*

KULL, PAUL A. (A) foreign trade promotion manager, World Information Service, New York City; student laborer in service, International Motor Co., *New York City*, (mail) 253 West 100th Street.

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SCHOFF, A. L. (M) assistant vice-president, Overman Cushion Tire Co., Inc., New York City, (mail) Knollwood Terrace *Caldwell, N. J.*

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THEE, FIRST-LIEUT. WALTER C. (S M) Quartermaster Generals Office, City of Washington, (mail) Massachusetts Institute of Technology, *Cambridge, Mass.*

WARNER, O. W. (A) service manager, Roamer Motor Car Co., *Kalamazoo, Mich.*

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WILSON, PAUL DUDLEY (A) sales manager, Bassick Mfg. Co., Chicago, (mail) 2121 Dime Bank Building, *Detroit.*

Applicants *for* Membership

The applications for membership received between Sept. 15 and Oct. 15, 1924, are given below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communication from members be sent promptly.

ABBOTT, HENRY L., automotive engineer, International Motor Co., *New York City.*

ABRAM, ERNEST SAMUEL, technical director, Bramwood, Ltd., Wellington Road North, *Hounslow, London.*

AKERMAN, JOHN D., student, University of Michigan, *Ann Arbor, Mich.*

ALBRIGHT, GEORGE, V., vice-president and service manager, Akron Oldsmobile Co., *Akron, Ohio.*

AYERS, HOWARD, student, Purdue University, *Lafayette, Ind.*

BARNARD, DANIEL P. 4TH, research chemist, Massachusetts Institute of Technology, *Cambridge, Mass.*

BARNARD, MARTIN C., electrical engineer, South Africa Railways, *Pietermaritzburg, Natal, South Africa.*

BATTLES, WALTER ESTES, student, University of Michigan, *Ann Arbor, Mich.*

BENSON, ALFRED D., student, Ohio State University, *Columbus, Ohio.*

BIRK, GEORGE W., student, Purdue University, *Lafayette, Ind.*

BISCHOFF, HENRY C., supervisor motor transportation, American Can Co., *New York City.*

BLANK, HARRY MADISON, student, Ohio State University, *Columbus, Ohio.*

BONEM, FRANK X., specification engineer, Chrysler plant, Maxwell Motor Corporation, *Detroit, Mich.*

BORRUOT, LUIS A., student, Ohio State University, *Columbus, Ohio.*

BOYCE, LEONARD D., engineer, Ensign Carburetor Co., *Chicago.*

BOYERS, J. G., treasurer and general manager, Ward Motor Vehicle Co., *Mount Vernon, N. Y.*

BRUN, JEAN JULES, administrateur-directeur, Ste. Ame Bleriot Aeronautique, *Suresnes (Seine), France.*

CALDWELL, STUART HILL, automotive frame engineer, A. O. Smith Corporation, *Milwaukee.*

CARROLL, CHARLES L., production manager, A. C. Spark Plug Co., *Flint, Mich.*

CLARK, MAURICE E., engineer, Bunting Brass & Bronze Co., *Toledo.*

COLLINS, C. H., factory distributor, *Utica, N. Y.*

COOK, HAROLD CHARLES, service engineer, Durant Motors, Ltd., Trading Estate, *Slough Bucks, England.*

COOPER, S. J., service manager, Anthony Motors, Inc., *Minneapolis.*

CROCKETT, C. V., JR., production department, Rickenbacker Motor Co., *Detroit.*

DANIELS, W. SMALLEY, president and general manager, New Era Spring & Specialty Co., *Grand Rapids, Mich.*

DAVIS, LAWRENCE V., president, L. V. Davis Engineering Co., *South Bend, Ind.*

DICK, JOSEPH, manager parts and service division, Durant Motors of Canada, Ltd., *Leaside, Ont., Canada.*

EASTMAN, E. H., assistant chief inspector, Benjamin Electric Mfg. Co., *Chicago.*

ELY, NATHANIEL, student, University of Michigan, *Ann Arbor, Mich.*

ENDERS, EGBERT E., road service representative, service department, Olds Motor Works, *Lansing, Mich.*

EVANS, CLARK, engineer, Morgan Wright Tire Co., *Detroit.*

FORD, FRANK W., vice-president and general manager, Allyne-Zerk Co., Subsidiary Bassick Mfg. Co., *Cleveland.*

FINGER, S. CYRUS, field service representative, Olds Motor Works, *Lansing ,Mich.*

FULWILER, ARTHUR W., sales engineer, W. J. Connell Co., *Boston.*

GILLIAM, FRANK S., secretary, Automobile Bearings Co., Inc., *Nashville, Tenn.*

GRIFFITH, MAX., student, Ohio State University, *Columbus, Ohio.*

HARRIS, MARK, body and chassis engineer, Oakland Motor Car Co., *Pontiac, Mich.*

HARRISON, HOWARD WILLIAM, student, Ohio State University, *Columbus, Ohio.*

HEARNEN, J. HARRY, proprietor of automotive electric service station, *Trenton, N. J.*

HOBBS, G. W., assistant professor of mechanical engineering, Michigan State College, *East Lansing, Mich.*

HOLADAY, WILLIAM M., student, Ohio State University, *Columbus, Ohio.*

HOWE, RUSSELL TROY, student, University of Michigan, *Ann Arbor, Mich.*

HUHN, FREDERICK ALVAN, student, Ohio State University, *Columbus, Ohio.*

HULL, R. WINTER, branch plant manager, Rex Mfg. Co., *Connersville, Ind.*

HUTCHINSON, B. E., vice-president and treasurer, Maxwell Motor Corporation, *Detroit.*

JOSEPHSON, HELGI B., student, Iowa State College, *Ames, Iowa.*

JUDSON, ROSS W., president, Continental Motors Co., *Grosse Pointe Park, Mich.*

JUNKERS, HUGO, possessor and director, chief-office, Junkers-Works, *Dessau, Germany.*

KELLS, CHARLES FRANKLIN, mechanical engineer, American Water Works & Electric Co., Inc., *New York City.*

KOVARICK, JOSEPH MATTHEW, JR., student, Armour Institute of Technology, *Chicago.*

KRAMER, WILBUR C., student, Armour Institute of Technology, *Chicago.*

LAGE, C. H., chief engineer, Linograph Co., *Davenport, Iowa.*

LAMBERT, W. C., superintendent, Westcott Express Co., *New York City.*

LEACH, KERMIT JAMES, student, Ohio State University, *Columbus, Ohio.*

LUTEN, DANIEL B., president, Luten Engineering Co., *Indianapolis.*

LUTZENBERGER, L. D., instructor, Ohio State University, *Columbus, Ohio.*

MALONEY, THOMAS EDMOND, F. C. Williams, Consulting Engineer, *San Francisco.*

MARLEY, SAMUEL P., research fellow, Mellon Institute, *Pittsburgh, Pa.*

MILLER, NEIL B., student, Ohio State University, *Columbus, Ohio.*

MITSCHKE, FRITZ, designer, International Motor Co., *Plainfield, N. J.*

MORSE, ALAN L., assistant aeronautic engineer, engineering division, Air Service, McCook Field, *Dayton, Ohio.*

OLENDORF, CHARLES W., student, Tri-State College, *Angola, Ind.*

OSAKI, SHUJI, student, Ohio State College, *Columbus, Ohio.*

OSLER, JAMES BELL, chief engineer, Carter, Paterson & Co., Ltd., *London E.C.1, England.*

PAINE, H. W., instructor in automotive, *Owatonna, Minn.*

PATTON, WILLIAM H., district manager, Edison Storage Battery Co., *New York City.*

PERKINS, HAROLD, sales, Stiner Piston Ring Co., *Detroit.*

PETERS, NEIL W., service manager, Otis H. Boylan, Inc., *Kalamazoo, Mich.*

PETERSON, RUDOLPH EARL, student, University of Illinois, *Urbana, Ill.*

QUACKENBUSH, F. A., manager, Cudahy Packing Co., *Chicago.*

RAGSDALE, W. H., laboratory assistant, Bureau of Standards, *City of Washington.*

RYBOLT, ARTHUR, student, Ohio State University, *Columbus, Ohio.*

SCHAFFER, EWALD E., mechanical engineer, Studebaker Motor Corporation, *Detroit.*

SKLAREH, CLIFFORD, vice-president, Lorraine Corporation, *Chicago.*

SLOCUM, G. A. R., sales manager, Skelly Oil Co., *El Dorado, Kan.*

SMITH, EARL B., engineer of tests, Bureau of Public Roads, *City of Washington.*

SPIRO, WALTER J., treasurer and general manager, C. Spiro Mfg. Co., *Dobbs Ferry, N. Y.*

STAHL, J. KELVIN, student, Armour Institute of Technology, *Chicago.*

STEELE, CAPT. GORDON H., Quartermaster Corps, U. S. Army, *City of Washington.*

STEEN, ADOLPH F., draftsman, tractor works, International Harvester Co., *Chicago.*

TINTERA, G. E., student, Armour Institute of Technology, *Chicago.*

VAUGHAN, HENRY P., student engineer, Detroit Lubricator Co., *Detroit.*

WARNER, H. J., vice-president, Federal Motor Truck Co., *Detroit.*

WEIGEL, A. R., production and factory manager, Velie Motors Corporation, *Moline, Ill.*

WERNER, CLARENCE H., service manager, Apperson Automobile Co., *Kokomo, Ind.*

WHITE, EDGAR LAWRENCE, student, Ohio State University, *Columbus, Ohio.*

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WOOD, NOEL CARPENTER, New York Edison Co., *New York City.*